AgroBioHeat

Promoting the penetration of agrobiomass in European rural areas

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D5.3 EU Strategic Plan

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Abbreviations

Abbreviation	Explanation
CAP	Common Agricultural Policy
EEA	European Environment Agency
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EU	European Union
FF55	Fit for 55 Package
GAEC	Good Agricultural and Environmental Conditions
GHG	Greenhouse Gases
GLOBIOM	Global Biosphere Management Model: developed by IIASA (International Institute for Applied Systems Analysis) to analyse to the competition for land use between agriculture, forestry, and bioenergy
GPP	Green Public Procurement
JRC	Joint Research Centre
LIFE	The EU's main funding instrument for environment and climate action. One of the long-term strategy options considered in the European Commission scenarios for 2050
MCP	Medium Combustion Plant
NECP	National Energy and Climate Plan
OGC	Organic Gaseous Compounds
PM	Particle Matter, e.g. Dust
PRIMES	Price-Induced Market Equilibrium System: a model for the simulation of the European energy system and markets, developed by Energy-Economy-Environment Modelling Laboratory E^3MLab of the National Technical University of Athens
REDII & III	Renewable Energy Directive recast and review
RES	Renewable Energy Sources
SRC / SRF	Short Rotation Coppice / Short Rotation Forestry
WHO	World Health Organisation

Project consortium

#	Full name	Acronym
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11	White Research Sprl	W.R.
12	Agronergy	AGRONERGY
13	Agence Innovation et initiatives locales	AILE

Table of contents

List of Tables

List of Figures

Executive Summary

The AgroBioHeat project is committed to identifying suitable policy interventions for the promotion of agricultural biomass and the development of rural areas' potential. Almost half of rural heat comes from fossil sources, showing a clear need to promote greener and more sustainable solutions in this context. Agrobiomass can be an enabler of this change, but new dedicated policies are still needed to ensure better mobilisation and provide local actors with the right instruments to lead the transition.

The untapped potential of the agrobiomass sector is clearly recognised in several European scenarios and political incentives must be implemented to foster a better mobilisation of agricultural residues and by-products, and to further expand the plantation of dedicated lignocellulosic energy crops, both woody (such as poplar, willow and other Short Rotation Coppices – SRC) and herbaceous (such as miscanthus).

There are several opportunities to promote policies supporting rural development and agrobiomass practices. The new delivery method of the Common Agricultural Policy (CAP) gives Member States more flexibility to adapt their strategies to local conditions and needs. The document presents the new CAP overarching objectives and features, including social conditionality and further attention to young farmers, showing how agrobiomass can play a key role in several of these areas. A comparison between the various proposals for the previous and next financing period is also developed stressing differences and similarities, together with a list of projects awarded with ERDF funding.

Five key recommendations are highlighted for supporting agrobiomass heating:

1. Develop national and regional plans to further build on local needs to tailor ad hoc policies for non-woody biomass.
2. Extend the existing ban on field burning to all agricultural residues.
3. Promote further investments to support modern biomass appliances.
4. Modernise energy and agricultural policies to further promote dedicated energy crops.
5. Reduce taxation on biomass fuels.

Finally, the document stresses the need for rural development measures focusing on a more effective agrobiomass mobilisation and logistic for a thriving rural sector. Bioenergy is closely interlinked with most of the EU-wide interventions and will play a major part in supporting the greening of rural heating. To ensure a just energy transition, the EU must support rural actors who often lack the resources to implement sustainable changes at the local level. Prosperous rural areas can become a reality with the proper financial support and exchange of best practices, but a clear long-term vision is needed.

In this context, agrobiomass can empower new jobs and growths in rural communities, supporting farmers and other actors by diversifying their revenues, better protecting their crops, and ensuring added value and circularity at the local level.

1. Introduction

The present document constitutes Deliverable 5.3 "EU Strategic Plan" of the AgroBioHeat project, prepared in the framework of Task 5.4 "EU Strategic Plan and Advocacy". The aim of the report is to identify suitable policy intervention areas at the EU level and to formulate specific policy recommendations for fostering the development of the agrobiomass heating sector in Europe.

The present report builds on the work outlined in AgroBioHeat Deliverable 5.1 / Part 1 "European framework conditions", which identified and analysed specific policy areas that have a direct or indirect impact on fostering agrobiomass supply, mobilisation and end-use: the Common Agricultural Policy, the Renewable Energy Directive, the Air Quality targets, the Renovation Wave, etc.

The focus of this document will be twofold – on one hand addressing the sourcing of non-woody biomass and on the other hand looking at policies regarding its utilisation including:

- The Renewable Energy Directive (REDIII)
- The Energy Efficiency Directive (EED)
- The Energy Performance of Buildings Directive (EPBD)

For the AgroBioHeat concept, the main targeted policy areas for intervention are related to Ecodesign, the Common Agricultural Policy (CAP) and the Rural Development (RD) measures. The CAP and RD are the policy areas directly affecting farmers and other actors in the agrobiomass-to-heat value chain. Policy instruments that foster the use of agricultural residues for energy purposes or that promote the cultivation of lignocellulosic energy crops will have a positive impact on the development of such value chains; while policy instruments that limit removals of agricultural residues or that do not support energy crops will have the opposite effect. In addition, a dedicated project Task (T5.5) focuses on the Ecodesign Regulation and the adoption of informed emission limits related to agrobiomass solid fuel boilers with capacities of up to 500 kW (and its possible extension up to 1.000 kW).

The main framework for the new CAP (until 2027) was only agreed at the end of 2021, after intense and time-consuming negotiations that brought to the establishment of a transitional period from 2021-2022 and the new CAP entering into force in 2023. Following the agreement on the main policy goals, the time for specific implementation measures – which can be used as vehicles for promoting new agrobiomass heating projects. Finally, the local and small scale of agrobiomass heating applications makes the RD programme a suitable vehicle for financially supporting new projects in the area.

The report is complemented by several Annexes that provide additional details on specific aspects:

- Annex I presents statistical data regarding the surfaces cultivated with lignocellulosic energy crops (miscanthus, willow, poplar, etc.) in the Member States.
- Annex II presents some additional statistical tables with data relevant to agrobiomass heating.
- Annexes III to VII focus on the prospects of agrobiomass heating in selected Member States with significant agrobiomass potential or with a very dynamic bioenergy sector (France, Germany, Poland, Italy, Austria). These Annexes are meant to complement the National Strategic Plans developed within T5.2 and extend the geographical coverage of the project strategic actions.
- Annex VIII summarises the EU events organised in the framework of the 2021-2022 Green Week.

2. The untapped agrobiomass potential in the EU

Today, 114 million European citizens live in rural areas where 45% of heating comes from highly polluting, fossil fuel solutions such as heating oil and coal, or fuels with a high impact on GHG and climate change. Furthermore, the off-grid building stock has quite diverse characteristics, but it is typically old and less energy efficient. Finally, approximately 1 in 4 people living in rural areas is at risk of energy poverty.[1] In this context, a better and cost-effective mobilisation of agricultural biomass could be an enabler of a just energy transition.

The untapped potential of agricultural biomass is clearly shown in several European scenarios related to the Green Deal: from the 2030 Target Impact Assessment to the energy system integration strategy, including the Circular Economy Action Plan and the post-2020 Common Agricultural Policy (CAP). The annual agricultural biomass production in the European Union has been estimated by the JRC at 956 million tonnes (Mt) per year. 54 % of it corresponds to primary products (grains, fruits, roots, tubers, etc.), e.g. economic production, while 46 % are residues, e.g. leaves and stems. Cereals account for more than half of the total EU economic production of agricultural biomass and almost three quarters of total residue production in the EU.[2]

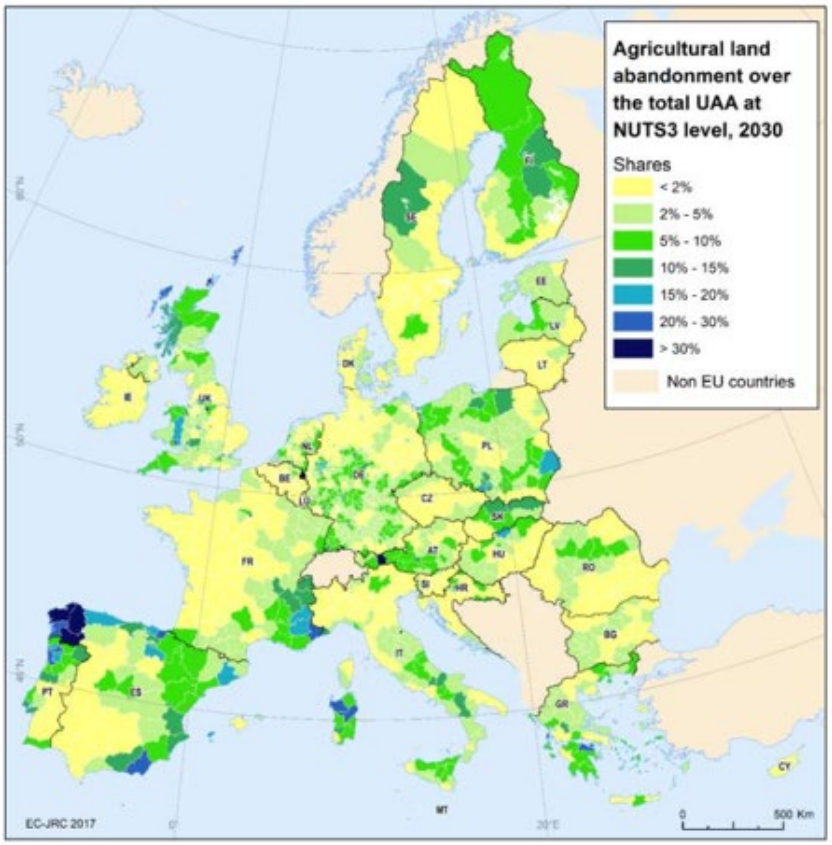

Figure 1 Estimated Agricultural land abandonment in 2030 by NUTS3 (Source: EC-JRC 2017)

Another potential source of agricultural biomass for energy in the EU is abandoned land. Figure 1 shows areas which are at high-risk of abandonment and according to the JRC, for the period 2015-2030 approximately 11% (more than 20 million hectares) of agricultural land in the EU is under high potential abandonment risk due to factors related to biophysical land suitability, farm structure and agricultural viability, population and regional specificities.[3]

[1] https://www.rural-energy.eu/wp-content/uploads/2018/11/Summary-Scenarios-for-decarbonising-homes-in-Europe%E2%80%99s-rural-areas-%E2%80%93-November-2018.pdf
[2] https://publications.jrc.ec.europa.eu/repository/handle/JRC109294
[3] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/agricultural-land-abandonment-eu-within-2015-2030

According to the JRC study, the abandoned land for the period 2015-2030 is expected to reach 4,2 million ha net (about 280 thousand ha per year on average) of agricultural land, up to 5,6 million ha of abandoned land by 2030, the equivalent of 3 % of total agricultural land. That land, which is not fit for food production can be used for dedicated energy crops with positive environmental, social and economic benefits.

Although the cultivation of dedicated crops for energy raises the *spectre* of the food vs. feed debate, statistics are quite clear that the land currently being used for lignocellulosic crops is insignificant compared to the abandoned land. Bioenergy Europe estimates that around 125.179 ha of dedicated lignocellulosic crops, mostly miscanthus, poplar and willow, are currently grown in Europe, which is only a small fraction of the total Utilised Agricultural Area (UAA).

Considering that the 2030 Climate Target Plans foresees an increase of approximately 117 million ha of land dedicated to agrobiomass, it is clear that new dedicated policies and supportive actions are needed. This is to ensure that a better mobilisation of agricultural residues is implemented, as mentioned in the impact assessment accompanying the climate law.

3. EU Strategic Plan

In order to assess the sectors with the highest potential for the use of agrobiomass, it is first necessary to analyse some figures on bioenergy in the European Union. In 2020, the Gross Inland Consumption (GIC) from biomass (regardless of the feedstock origin) in the EU27 reached 139.277 ktoe, while the total GIC (for all fuels) accounted for 1.340.145 ktoe, meaning that biomass represented around 10,5% of the overall GIC of the European Union. A similar analysis can be performed on the Final Energy Consumption (FEC) level, with biomass accounting for 10% of the European FEC (88.484 ktoe out of 885.764). If we breakdown the FEC of biomass by types of fuel, we notice that Primary Solid Biofuels (woody/agro biomass) represent more than three quarters of the biomass consumed (76,27% in 2020 according to Eurostat), which illustrates the extent to which the use of solid biomass is prevalent in Europe.

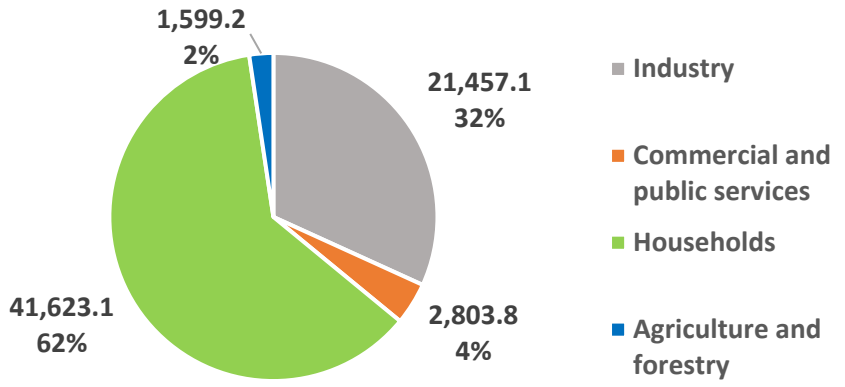

Figure 2 Breakdown of the final energy consumption of solid biofuels per end-use sector in the EU27 in 2020 (ktoe and %). Source: Eurostat

If we focus exclusively on solid biomass, and more specifically on its final uses, we can see that the vast majority is consumed for residential purposes (up to 62%). The second most important sector is industry (32%), followed by commercial and public services (4%) and finally agriculture and forestry (2%). Historically, heat production was one of the main uses of biomass, and this observation is still valid today. If we look at the consumption of the EU27 to cover its heating and cooling needs, we see that it amounts to 452.996,8 ktoe.

Only 23% of this consumption, i.e. 104.589,7 ktoe, comes from renewable sources, but the most interesting thing to note is the overwhelming dominance of biomass among these renewables. Indeed, it represents 84% of the renewable mix, or 87.819,9 ktoe. This portion of biomass varies according to the Member States, but 24 countries out of the 27 forming the EU relied on biomass to provide more than 70% of their renewable heat in 2020. The complete table with the exact consumption of each Member State can be found in Annex III.

Thus, we see that biomass occupies a prominent place in the renewable H&C mix, but it is worthwhile to analyse the current energy mix of various sectors in more details by including fossil fuels as well. Indeed, the current geopolitical situation and the associated consequences (reduced energy imports, soaring prices, etc.) have dramatic consequences on the European energy system, and it is therefore appropriate to analyse the different sectors to evaluate the various options available to them.

Figure 3 represents the energy mix of households in the European Union in 2020. Natural gas represents approximately half of the fuels consumed by households, followed by solid biomass (26,4%), oil products (19,41%) and finally coal (4,27%). When we consider the breakdowns shown in the figure, we can observe that dependence on gas imports is extremely high.

However, biomass also occupies a significant share, and it is highly likely that this will continue to increase in the coming years. Indeed, most Member States have the ambition to phase out the very polluting coal systems in favour of renewables, with biomass allowing for a less expensive adaptation of these installations. The increasing attractiveness of renewable sources due to the reduction of CAPEX (capital costs) and OPEX (operational costs), coupled with the current high price of fossil fuels, could also make new sources appear in this graph at the expense of natural gas and oil.

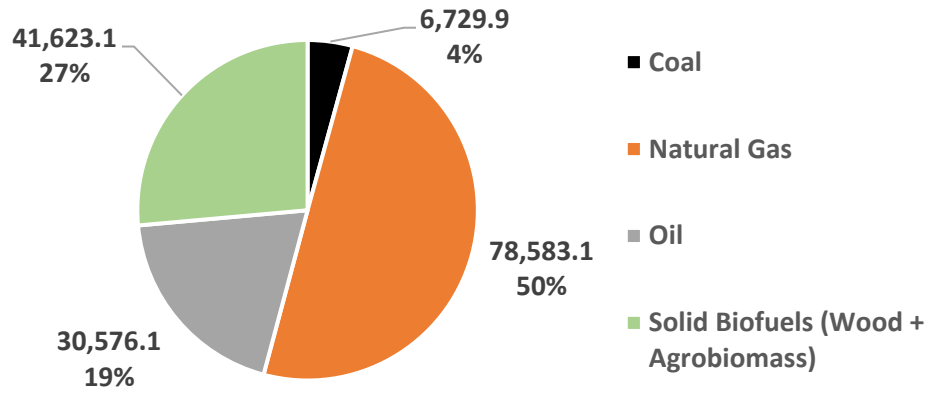

Figure 3 Fuel consumption for residential heat in 2020 in the EU27 in ktoe and %. Source: Eurostat

Figure 4 shows fuel consumption focusing on the commercial sector. In this case, the dominance of natural gas is even more pronounced, with nearly three quarters of the mix occupied by this energy source. The remaining 27,64% of the mix is occupied mostly by oil products, and biomass represents only a small proportion (5,88%).

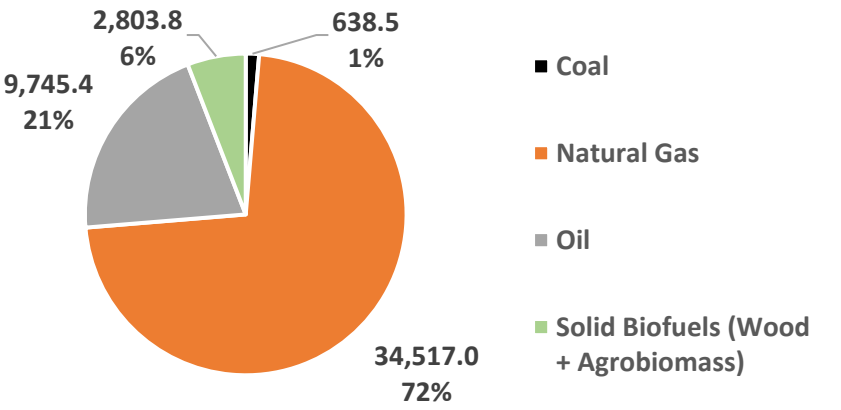

Figure 4 Fuel consumption for commercial/public services sector in the EU27 in 2020 (ktoe and %). Source: Eurostat

However, as is the case for the residential sector, the share occupied by coal can easily be converted to biomass and thus promote the decarbonisation of the sector. In addition, because of its overwhelming reliance on natural gas, the commercial sector is the one that can potentially suffer the most from the current price increase. It is therefore likely that several commercial facilities already installed will seek to diversify their fuel and that new sources will appear in this graph in the coming years.

When looking at all sectors using biomass for heating, district heating is particularly interesting in terms of growth potential. Figure 5 illustrates the current distribution of fuels being used to produce decentralised heat. As in the previous two cases, natural gas occupies the largest share, but in a reduced proportion (41,17%). We also note here the appearance of biomass in its other forms (gas, liquid, waste), probably due to the fact that decentralised production facilities (e.g. CHP) are generally larger and able to process a wider variety of fuels.

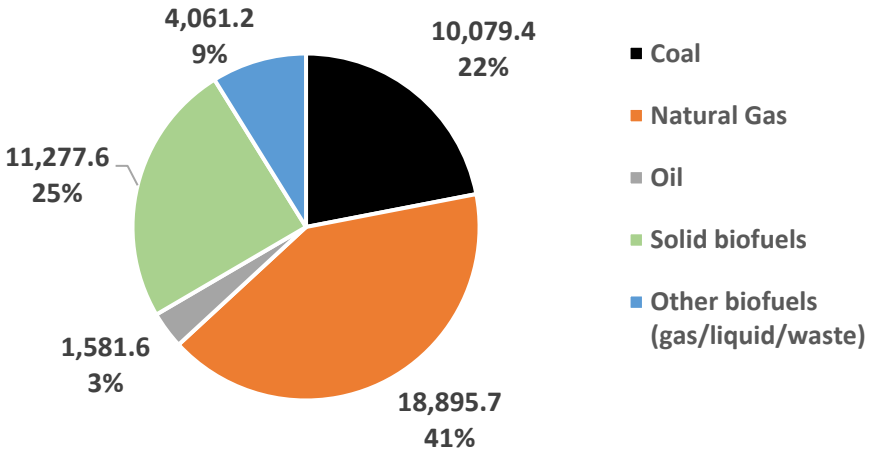

Figure 5: Fuel consumption for derived heat in the EU27 in 2020 (ktoe and %). Source: Eurostat

What is particularly interesting in this graph is the share occupied by coal, amounting to almost 22%, or a little more than one fifth of the mix for the year 2020. Given the desire of most Member States to move away from coal toward greener sources, this is a significant market share to replace and one for which biomass could be well-suited, given the share it already occupies and the retrofitting possibilities from coal-fired facilities. In addition, in the case of decentralised heat, feedstock storage issues are generally less significant than for individual residential or

commercial facilities. In the case of installations located in rural areas, the supply would also be easier, which would favour the expansion of biomass in the decentralised heating sector.

Given the potential of agrobiomass for residential heating, it is also worth looking at the distribution of the European population based on the degree of urbanisation. According to the latest available Eurostat data, the population distribution is fairly balanced. Indeed, the EU27 currently has 39,53% of its population living in cities, 30,41% living in towns and suburbs and 30,06% in rural areas. It is interesting to note, however, that this stability at the Union level is not verified at the Member State level, as the table in the Annex indicates. We see that the proportion of the population living in cities varies from 19,1% in Luxembourg all the way to 88,8% in Malta.

3.1. Agrobiomass potential

An independent study commissioned by CONCAWE in August 2021[4] (Panoutsou & Maniatis, 2021) focused on the amount of sustainable biomass available in 2030 and 2050 under different scenarios. There are three scenarios, depending on the intensity with which biomass is mobilised. Focusing on the median scenario, "improved mobilisation in selected countries", the assumptions of this model are the following:

- Improved management practices in i) agriculture, such as crop rotation, cover crops, agroforestry, etc., which can improve soil and increase biomass productivity and ii) forestry such as improved harvesting techniques, fertilisation (where possible), storage and transport optimisation, etc.
- Significant amounts (50%) of unused, abandoned, and degraded land are used for biomass crops.
- Emphasis remains on the use of residues and wastes in the energy and non-energy biobased sectors.
- Biodiversity is included in the estimated potential, accounting for: i) conservation of land with significant biodiversity values (direct and indirect), and ii) land management without negative effects on biodiversity.

Based on this study, a table showing the potential for bioenergy of different agricultural feedstocks was developed (Table 1).

This table highlights several things, starting with the variation of the potential that suggest which type of agricultural feedstock is most likely to be used for energy. For example, the theoretical maximum potential of agricultural pruning is highest in Spain and is worth about 3,5 Mtoe, while the theoretical maximum potential of cereal straw is worth approximately 25 Mtoe in France, the leading country in this field. We can see that the potential for pruning is about 7 times lower than that of cereal straw for the two leaders in these feedstocks. However, there is also a huge variation within Member States depending on the feedstock, and a given type of agricultural residue may represent a huge potential in one country but no potential in another. As with many other things, proximity is paramount and the development of agrobiomass as an energy source will therefore depend on local availability.

[4] Panoutsou, C., & Maniatis, K. (2021). *Sustainable biomass availability in the EU, to 2050*.

Table 1 Sustainable potential for Bioenergy in 2030 for several types of agro feedstocks in Mtoe. Source: Panoutsou, C., & Maniatis, K. (2021). Sustainable biomass availability in the EU27 + UK, to 2050

Geo Entity	Cereal straw	Maize stover	Oil crop field residues	Agricultural pruning	Manure	Secondary Agricultural residues	Lignocellulosic crops
EU27+ UK	42,195	8,805	5,663	2,408	24,114	19,319	24,999
AT	0,659	0,259	0,066	0,023	0,115	4,666	0,179
BE	0,432	0,100	0,000	0,013	1,060	0,273	0,126
BG	1,382	0,429	0,691	0,150	0,000	0,116	0,642
CZ	2,407	0,168	0,039	0,014	0,344	0,275	0,495
CY	N.A.	N.A.	N.A.	N.A.	N.A.	0,003	0,024
DE	9,267	0,614	0,023	0,064	5,761	1,700	2,004
DK	0,338	0,000	0,027	0,000	1,433	0,401	0,090
EE	N.A.	N.A.	N.A.	N.A.	0,057	0,031	0,086
EL	0,266	0,192	0,071	0,083	0,143	0,244	0,271
ES	3,540	0,438	0,456	1,395	2,554	1,420	6,309
FI	0,732	0,000	0,011	0,001	0,201	0,191	0,615
FR	9,951	2,189	1,850	0,055	2,322	6,341	2,653
HR	0,208	0,397	0,040	0,008	0,172	0,046	0,013
HU	1,497	1,062	0,649	0,063	0,229	0,188	1,144
IE	N.A.	N.A.	N.A.	N.A.	1,003	N.A.	1,018
IT	1,498	1,133	0,130	0,197	2,923	1,035	0,253
LT	0,115	0,003	0,021	0,000	0,172	0,072	0,011
LU	0,040	0,003	0,004	0,000	N.A.	0,000	0,148
LV	0,066	0,000	0,009	0,000	0,029	0,045	0,387
MT	N.A.	N.A.	N.A.	N.A.	N.A.	0,001	0,001
NL	0,190	0,051	0,007	0,009	0,000	0,445	0,141
PL	6,466	0,407	0,504	0,262	2,501	1,096	4,144
PT	0,005	0,025	0,011	0,000	1,863	0,161	0,204
RO	1,832	1,162	0,910	0,066	0,573	0,293	3,575
SE	0,821	0,001	0,046	0,001	0,287	0,190	0,361
SI	0,002	0,000	0,000	0,001	0,373	0,021	0,015
SK	0,479	0,173	0,097	0,005	0,000	0,064	0,090
UK	1,751	N.A.	0,286	0,008	0,143	1,015	1,071

Another interesting point when analysing this table is the fundamental difference between the first six columns and the last. Indeed, the first six can be considered as *real potential* because they all represent residues related to agricultural activity. The last one represents the lignocellulosic crops, which are crops and whose contribution to the energy mix is not based on residues as is the case for the first six columns.

The continuity of agricultural practices should therefore make it easier to reach these forecasts for cereal straws, maize stover, oil crop field residues, agricultural pruning, manure and secondary agricultural residues. For lignocellulosic crops, one way to reach the theoretical potential for 2030 is to convert abandoned or unused land for the cultivation of these resources. Indeed, energy crops (such as miscanthus) are generally less demanding in terms of soil quality for their development and can therefore be grown on land not suitable for conventional agricultural production. They can thus contribute to the energy independence of the Member States while reducing the amount of abandoned/unused land, and even protecting and restoring soil.

Potential for further development in the production and use of agrobiomass for heating

Determining the current use of agrobiomass for energy purposes is unfortunately a very complicated exercise. Indeed, this feedstock is frequently used locally for circularity purposes and despite the advantages that this represents, easy traceability is not part of it. Nevertheless, in view of the data in the previous table, it is clear that potential is quite significant and that it is not fully exploited in the EU Member States. It is therefore appropriate to look at some factors that could potentially accelerate the development of the use of agrobiomass for energy purposes.

The improvement of current agricultural machinery or the development of new technologies is a key issue, as it has the potential to reduce the workload of farmers while allowing them to increase crop yields. In the case of most agricultural feedstocks for energy production (such as straw or maize stover), an increase in crop yield would also lead to an increase in the quantity of valuable residues.

Another factor to promote the development of agrobiomass is to foster knowledge exchanges among users and producers in the agricultural field. This knowledge can be related to cultivation techniques, new crop varieties better adapted to changing soil conditions, best practices implemented by other users, etc. Promoting the exchange of knowledge is essential when seeking to establish and develop skills on a European scale.

A third point of interest to better enable the development of agrobiomass is to increase the number of farmers. Indeed, the rural exodus is becoming more and more significant, especially among the younger generations. A potential solution might be to set up measures to make rural areas more attractive in order to motivate people to stay and thus increase the number of farmers.

Finally, a major factor for the promotion of agrobiomass is to make better use of abandoned land. Indeed, according to Eurostat, there is still a significant proportion of abandoned land or at high risk of abandonment in the EU Member States, despite a downward trend since 2012. It is obviously utopian to want to convert all abandoned land into agricultural land, as some is not suitable for agriculture due to several reasons. Indeed, this land can be polluted by components making the crops unfit for consumption; have topological characteristics that do not allow it to be cultivated easily (soil too steep, subsoil too stony, etc.); or in some cases be totally "exhausted" by years of intensive cultivation that have gradually made it unproductive. In several cases, energy crops are a good way to restore depleted or contaminated soil. Indeed, the cover of bare land allows to reduce erosion (by wind and rain for example), with the roots playing a key role by allowing for the storage of carbon in the soil and also by reducing its compaction.

And last but not least, those crops can be used by various organisms for food and protection thus building biodiversity networks.

A similar analysis was performed for a selection of European countries, such as Austria, Germany, France, Italy and Poland. These national factsheets can be found in Annexes III to VIII.

3.2. Main barriers to the development of agrobiomass

There are several barriers to the development of agrobiomass heating solutions. These obstacles can be of different natures and affect different aspects related to the use of agrobiomass. One challenge is the need for large storage spaces for the feedstock necessary for the appliances. Indeed, this mainly concerns tighter areas, such as cities, where space is both more limited and more expensive, which could slow down the development of agrobiomass in more urbanised areas. However, various solutions exist to this problem, but they still require certain additional costs. One of them is feedstock pelletisation, which generally provides a higher energy density fuel, thereby reducing the space required for storage. Another potential solution would be to focus on decentralised systems accompanied by a district heating network that would allow for the relocation of plants further away from the high population areas and move the storage location to make it more accessible.

A second barrier to the development of agrobiomass is that the combustion of this type of feedstock can result in high emissions of pollutants and other problems in the operation of the facilities. In this case, several options are already available, such as the use of modern plants with specialised boilers equipped with primary and secondary emission control devices, and with automated feeding systems that reduce the risk of improper handling. When compared to fossil fuel-based solutions, agrobiomass solutions are generally characterised by a higher CAPEX (capital expenditure), hence specific support must be granted to address the existing financial bottlenecks. Once again, multiple solutions are available to overcome this issue, such as investment subsidies for appliances and other support mechanisms. Moreover, as time goes on, the technologies will become more refined and democratised, thus reducing the acquisition costs of the appliances.

Another parameter identified as a potential barrier is soil degradation (nutrient depletion, erosion, etc.) which makes the land unsuitable for the cultivation of certain crop varieties. Nevertheless, some plants are less sensitive to soil quality then others and can even regenerate depleted soil through nitrogen and carbon fixation. Continuous cropping regimes can also help reduce erosion, which is a major cause of soil degradation. All such crops can then be used for energy purposes if they are not suitable for human consumption.

Finally, what could slow down the growth of agrobiomass use for energy is the conversion of some agricultural areas into land used exclusively for environmental benefits. Such areas may be reserved for biodiversity or carbon farming, and although these initiatives can be beneficial to achieve the objectives set by the European Commission, the competition for space could hinder the development of agrobiomass.

4. The new Common Agricultural Policy (2021-2027)

The reform of the Common Agricultural Policy (CAP) was formally agreed in 2021 after a long and lengthy process. The new legislation will enter into force in 2023, following a transitional period during 2021-2022 when previous rules would still apply.

The two pillars of the previous CAP (Direct Income Support and Rural Development) are combined under a single Strategic Plan, focusing all funding and policy tools toward the same 10 key objectives. This decision was taken to avoid distortive support measures and to allow Member States to implement more targeted measures suitable for their specific local needs.

The revised legislation will seek to provide more targeted support to meet the needs of farmers and Member States, giving them more flexibility to adapt specific measures to local conditions, making this a new delivery model more performance oriented.

The reform paves the way for a greener, fairer, and performance-oriented CAP ensuring a sustainable future for EU farmers and citizens. This new CAP fits into the broader context of the Green Deal and matches the EU's ambition of coupling economic and societal growth with more sustainable practices. On top of this, the new CAP will be a key tool in achieving the objectives of two specific strategies where agriculture and rural development are key: the Farm to Fork and biodiversity strategy.

4.1. A new delivery model for the CAP

As mentioned before the CAP agreement introduces a new delivery model, which will bring both pillars under a single programming instrument, namely the CAP Strategic Plan. The aim of this new plan is simplifying the process and granting Member States more flexibility, whilst supporting both rural and agricultural development. As part of the agreement, EU countries will be required to develop a strategic plan for the period 2023-2027, which will set out how EU financial support will be implemented, in line with the overall CAP objectives. Each strategic plan is expected to be completed at the end of 2021, followed by a review, however, several Member States were late in the process.

This is one of the major changes to the previous CAP, which was more prescriptive in the way each country would apply it. In this way, governments will have greater freedom to shape rules and funding allocations around the needs of their farmers and rural communities, if those are in line with EU standards and objectives.

The beneficiaries' payments will continue being linked with mandatory provisions called *conditionalities,* including good agricultural and environmental conditions (GAECs). The *green direct payments* from the previous CAP were based on three practices: crop diversification, maintenance of permanent grassland and dedicated land to ecological focus areas. Now, the most effective aspects will be incorporated in two new rules for farms above 10 hectares, with some exemption for those farms fulfilling the CAP obligations, such as organic farms:

- **GAEC on soil protection and quality**: which will require crop rotation and allow crop diversification only when it contributes to preserving the soil potential.

- **GAEC on biodiversity and landscape**: for which 4% of land must be dedicated to non-productive elements and areas, including fallow land. This obligation can be lowered if farmers top up that total to 7% through an eco-scheme, or they devote significant additional land to catch crops or nitrogen-fixing crops.

The new CAP will also include a social conditionality dimension, strongly supported by the Parliament, that links payments to compliance with certain European labour law provisions. Young farmers (up to 40 years old) that set up a farm will have a new mandatory minimum level of support, with 3 % of the direct payments' envelope reserved for them. This could be granted through income support, investment, or start-up aid.

4.2. Eco-schemes and Rural Development

The main greening intervention is the creation of the so-called Eco-Schemes for which 25% of the direct payments will be allocated. This will provide stronger incentives for farmers to implement climate and environment friendly practices.

Member States will have the obligation to offer these schemes, however farmers will have the choice of signing up or not on a voluntary base. Eco-schemes will focus on a common list of eligible areas defined by the Commission including:

- Organic farming
- Agroecology
- Precision farming
- Agroforestry or carbon farming.

Although bioenergy is not explicitly mentioned in this proposal, afforestation, grassland and biochar to soil in conjunction with biomass utilisation (all included in the carbon farming section) have the potential to address the four benefits linked to carbon farming (climate mitigation and resilience, soil quality and new business model).

A *learning period* will be in place for the first two years – 2023 and 2024 – during which EU countries can spend less than the allocated percentage in case of a low up-take of the schemes by farmers. Any unused funds in the learning period will have to be compensated for by the end of the CAP in 2027.

The previous *second pillar* on rural development will ring-fence resources for climate and environment-related interventions. This will result in 35% of the funds being allocated to agri-environmental management practices and investments, and 50% for areas with natural constraints.

4.3. CAP Specific Objectives & Strategic Plans

The revised CAP will build around 10 key objectives that focus on social, environmental, and economic ambitions and will be the starting point for the development of the CAP strategic plans.

Figure 6 CAP Overarching objectives. Source: European Commission

Several of these objectives support the greening of the agricultural sector and directly address climate action. Rural areas and climate change are the more relevant for the development of non-woody biomass as they support the deployment of sustainable energy and the inclusion of bioeconomy and sustainable forestry practices to further promote social inclusion, employment and prosperity in rural communities. In this context, sustainable bioenergy can play a key role in several of the objectives.

Strategic plans

To assess possible threats and potential for the use of CAP at national level, each Member State developed a SWOT analysis and identified key priorities based on clear impact and result indicators. The priorities were established looking at local conditions of the agricultural sector and ranked in order of importance. Following up on the analysis, the Commission developed customised recommendations for each country, setting up tailor made intervention strategies.

All the plans need to be approved by the Commission based on the quality of the objectives, the ambition of the measures and the resources allocated. On top of this, all plans need to be aligned with the new specific objectives and respect results and impact indicators for each of them (e.g. climate change includes bio-based and increased renewable sources in agriculture). All the plans have been published and the full list is available on the European Commission's website.

For every Member State, we can distinguish two phases in the preparation of the Strategic Plan: a phase of diagnosis and needs analysis which must be finished considering the need for Member States to present their Strategic Plans this year and a phase for defining its intervention strategy, at different levels of design.

In the first phase, the starting documents were prepared by the groups specialised in each objective, as well as the SWOT analysis and the needs analysis, in which the observations of the Ministry for the Ecological Transition and the Demographic Challenge have been considered, as well as organisations of agricultural producers, environmental agents, as well as of other external interlocutors who have sent their contributions.

5. Supporting agrobiomass heating within the new CAP

As mentioned before, Rural Development used to be the second pillar' of the CAP, complementing the system of direct payments to farmers and measures to manage agricultural markets. These policies are implemented through Rural Development Programmes (RDPs).

In the new CAP, most of the opportunities for agrobiomass will come from Rural Development measures which will continue to support environmental and climate friendly practices. To simplify the process, the existing 20 measures and their 64 sub-measures will be streamlined into eight broad new interventions supported by the EAFRD. These policy interventions[5] will be tailored and defined by Member States ensuring greater flexibility and allowing them to design these interventions according to regional and local needs. In the new funding period, rural development interventions will have to be co-financed by national budgets and approved by the European Commission. The selection of projects and the granting of payments are handled by local authorities.

Five out of eight of these interventions are closely related to bioenergy and can have a direct and positive impact on the promotion of agriculture residues and other agrobiomass feedstock:

- **New investments** for on-farm boilers in rural communities can incentivise farmers to use their residues to produce renewable heat.
- The intervention on **sustainable forest management** will ensure better land use and more environment friendly practices.
- **Improving logistics** in rural areas will be fundamental for a better mobilisation of agrobiomass.
- **Environmental, climate and other management commitments** where bioenergy can play a key role in promoting sustainable environmental and climate practices at local level.
- **Support for young farmers and rural business start-ups** through knowledge exchange and information have the potential to support exchange of information and practices related with bioenergy.

In particular, investments and cooperation are quite relevant for agrobiomass. The CAP should promote investments to foster green energy demand on-farm and in rural municipalities. This will be key in

[5] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/measures_en#measuresinthefuturecap

developing short value chains and increasing efficiency in agrobiomass logistics. The interventions focusing on cooperation must include measures to support agricultural cooperatives, the creation of consortia to better mobilise agricultural residues and coordinated logistics centres.

The CAP can play a key role in addressing climate change and support the sustainable management of natural resources. The EU must support rural actors in the energy transition and the fight against climate change. Municipalities and local authorities, especially in rural areas, often lack the technical skills to implement sustainable changes in the rural sector. This is both an issue of awareness and resources availability. Research and innovation can actively support the expansion and growth of rural communities. Training and knowledge exchange can also be a catalyser for this process and accelerate the spread and adoption of these innovations.

In the rural context, the EU must stimulate new economic activities and help those which do not have the means to overcome the development challenges by themselves. Different streams of financing are available to this end: the rural development fund, Horizon Europe framework programme and the Cohesion Fund through the Just Transition Mechanism. Agrobiomass heating can support rural areas by harnessing opportunities in the circular and sustainable bioeconomy.

Prosperous rural areas can become a reality by sharing and supporting experiences across the internal market and be revitalised through cooperation: to fully exploit their potential, rural areas need best practice and knowledge exchange to enable industry entrepreneurs, SMEs and cooperatives to thrive there as well. Agrobiomass heating can create these new opportunities in the circular and sustainable bioeconomy through the Rural Development programme. However, to achieve this goal the EU will need a clear long-term vision for rural areas development.

On top of this, Member States have the possibility to provide targeted aid for a few selected agricultural sub-sectors. This measure is called *coupled income support* and can only be provided for very specific needs, given the strong distortive impact it can have on the market. The Commission is gradually moving away from these support measures, using them only for a limited list of actions. The new CAP will allow coupled income support for Short Rotation Coppices (SRC) but not for fast growing lignocellulosic crops, such as miscanthus and switch grass. However, this doesn't constitute a major change, since in the previous funding period agrobiomass also had only limited direct mentions under this chapter.

This is also in part reflected in GAEC 4, where, in the context of the ecological focus areas, miscanthus and SRC plantations in buffer zones have been linked with environmental advantages, such as reducing the leaching and run-off of nutrients and pesticides into surface waters[6], willow being a clear example of this with its filtering properties as covered by existing literature[7]. The analysis informing the European Commission report on the implementation of the ecological focus area obligation under the green direct payment scheme indicates a positive impact of landscape features on invertebrates, birds and terrestrial plants, while for reptiles and amphibians the presence of buffer strips and fallow land gives higher positive impact scores.

[6] https://search.proquest.com/openview/98c8908107a7ffeef048a6fbfe2eec1a/1?pq-origsite=gscholar&cbl=866396

[7] https://www.researchgate.net/publication/222939878_The_prospects_for_willow_plantations_for_wastewater_treatment_in_Sweden

6. Sustainable Carbon Cycle Initiative

Several EU and international scenarios show that by 2050 energy crops, agricultural residues and streams will have a prominent role in the future energy mix. Considering the current contribution of this sector, today we are still far away from achieving this result. Overall, bioenergy will keep on having a significant role and the sector is expected to keep on growing. However, as we saw before, there are no specific measures for agricultural crops in the revised CAP. Hence how do we answer this increasing demand? Looking at the European policy landscape there is another initiative that can further promote the potential of non-woody biomass: the Sustainable Carbon Cycles.

Following the publication of the Farm to Fork strategy, the Commission is now focusing on the issue of carbon removal. In particular, this initiative highlights key challenges regarding carbon removal, including the role of carbon farming.

The term *carbon farming* refers to practice to mitigate climate change at farm level managing the carbon pools, flows and GHG fluxes. This can consist of several types of activities, including, but not limited to:

- afforestation and reforestation initiatives
- development of dedicated crops for conservation and landscape features
- agroforestry and other forms of mixed farming
- restoration, rewetting and conservation of peatlands and wetlands.

Furthermore, carbon farming has several benefits, especially when implemented locally, as it promotes and increases carbon removals, creates additional income for land managers and farmers, boosts biodiversity and nature protection and conservation, and enhances climate resilience of farms and forests.

In the upcoming years, sustainable carbon cycles are expected to be strongly scaled up, making carbon removals an important part of the energy transition. In 2022 a certification for carbon removals is expected to be developed and in 2023 the possibility of applying the polluter-pays-principle to agricultural practices will be assessed to be extended.

By 2030, carbon farming is expected to work closely with other policies of the Green Deal and should support the achievement of the 310Mt CO2eq net removal target for the land sector. Agrobiomass, such as fast-growing grasses and short rotation coppices should be included in the Carbon Farming schemes to build in the potential of these new applications.

7. Bioenergy in the long-term vision for the EU's rural areas (2040)

As mentioned before, the development of rural innovation ecosystems and the exchange of best practices will be key to implementing an efficient long-term vision for EU's rural areas. In order to achieve this, Europe needs actions targeting smart solutions for smart rural communities, innovations in farming and rural areas.

The graph below shows the main drivers shaping the future of rural areas according to the European Commission "A long-term Vision for the EU's Rural Areas".[8] Agrobiomass already supports several of these drivers since it promotes the diversification of economic activities for famers and empowers rural communities by bringing added value and resource reuse at local level. Furthermore, agrobiomass will be a pivotal sector to increase environmental and climate resilience and can support rural municipalities in the energy transition and in fighting climate change.

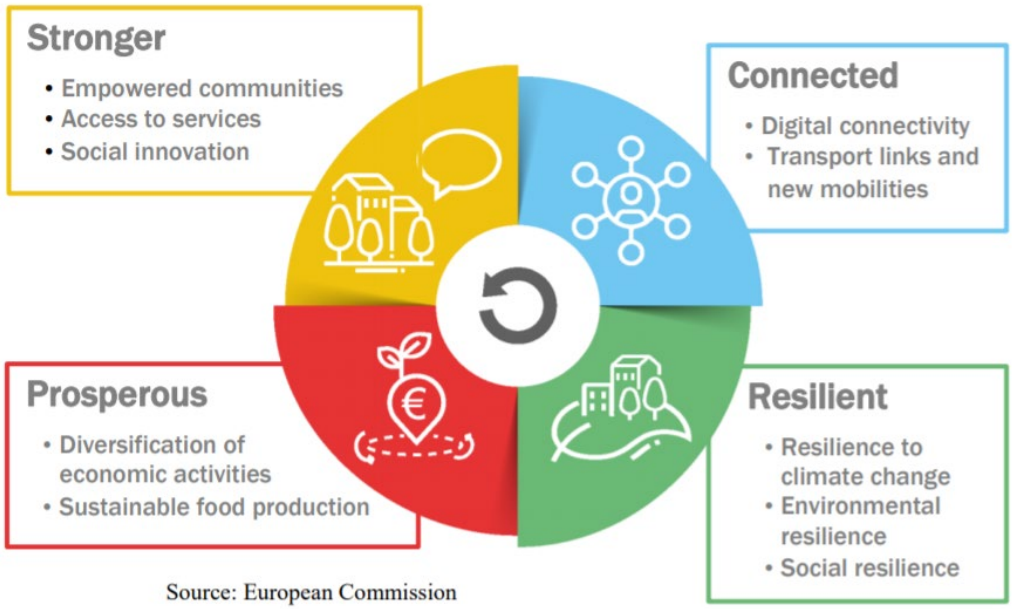

Figure 7 Main drivers shaping the future of rural areas for 2040. Source: European Commission

In this context, the bioeconomy is the only system providing food, feed, and ecosystem services. The European Bioeconomy strategy was revised in 2018 and now focuses more on rural development and possible synergies with the CAP.[9] Given that agriculture is one of the fundamental components of the EU bioeconomy, with a high relevance for rural employment and farmers' income, a sustainable bioeconomy should be promoted by the EU in connection with the development of rural areas.

[8] https://ec.europa.eu/info/sites/default/files/strategy/strategy_documents/documents/ltvra-c2021-345_en.pdf
[9] https://ec.europa.eu/info/research-and-innovation/research-area/environment/bioeconomy/bioeconomy-strategy_en

The EU foresees supporting prosperous rural areas in several ways:

1) A rural work stream within the Covenant of Mayors will be created to share best practices and support rural municipalities in accessing EU funding to support the green transition.
2) The use of structural funding to finance the renovation wave and further seize the opportunity to finance investments through territorial instruments of the ERDF and the EAFRD.
3) Addressing rural areas in the New European Bauhaus.[10]

Rural areas can be significant actors in the context of climate change and biodiversity restoration, but to do that they will need a stronger recognition and the right advisory support.

The promotion of new, diverse, and local value chains can bring added value of the bioeconomy to rural areas. The development of this sector will also ensure economic and social improvements while protecting biodiversity and the local environment. Circular bio-economy value chains allow new opportunities for jobs and growth and can further support farmers and rural communities in adapting to climate change, diversifying their revenues, and protecting their crops from adverse weather events like floods, droughts, or heatwaves, which unfortunately are more and more common.

The EU should guide rural actors in the energy transition and ensure that the voice of municipalities is heard in key initiatives and facilitating the assessment of their needs across the EU. This is a crucial opportunity to promote agrobiomass and invest in short value chains and systems to ensure a better mobilisation of agricultural residues.

A more efficient mobilisation of agrobiomass has great potential in terms of climate benefits as it can achieve emission reduction, while at the same time deliver several benefits related to water and soil management, biodiversity, and socio-economic issues.

Bioenergy Europe submitted a reply in the public consultation for the long-term vision for rural areas, highlighting the benefits that can be gained from the utilisation of agricultural residues and cultivation of lignocellulosic energy crops. The full text can be found here.

[10] https://ec.europa.eu/info/sites/default/files/strategy/strategy_documents/documents/ltvra-c2021-345-annex_en.pdf

8. Opportunities for agrobiomass heating in Fit for 55

In July 2021 the European Commission published the Fit for 55 (FF55) Package after assessing that Europe was not on track to reaching the climate neutrality objective by 2050. To achieve this higher ambition, the decarbonisation of the heating sector will be of crucial importance, and several policy files can work as enablers to further promote the switch to renewable sources.

The energy transition will need a holistic approach and should guarantee that synergies between key policies are maximised. The Renewable Energy Directive, the Energy Efficiency Directive and the Energy Performance of Buildings Directive are closely linked and mutually reinforcing, so their requirements should be further harmonised. The combination of energy efficiency and renewables should be optimised to lower overall heating costs bringing benefits to society and consumers. To achieve this, we call for an obligation to reach even more ambitious levels of on-site and nearby renewable heat sources in buildings, industries, and districts. In this context, agrobiomass is just the perfect solution to promote rural development whilst pursuing higher ambition for our environmental and climate targets.

This is the moment to take strong and decisive action and maximise the opportunities for several EU policies to decarbonise our heating sector. The Fit For 55 package should create financial incentives that cover the costs of connecting to district heating with renewable sources, modernising heating appliances, upgrading existing renewable appliances, and switching from fossil fuels to renewables like bioenergy.

8.1. Renewable Energy Directive (RED)

The revision of the renewable energy directive (REDIII) demonstrates a clear willingness to address decarbonisation with concrete measures and achieve higher ambitions. The proposal introduces a new RES target of 45% and a benchmark for 49% of renewables in buildings, both in urban and rural areas. On top of this, the draft recognises the specificities of the heating sector that need to be considered to ensure a sustainable, yet effective transition. Despite this renewed attention, a deeper focus on renewable heat solutions in rural areas is still needed and must be further implemented.

The new binding targets for the renewable heat obligations (article 23) is a positive step forward. However, the average annual increase of 1,1 percentage points (pp) corresponds to the current forecasted increase in renewable heat in the EU Member States according to their National Energy and Climate Plans (NECPs). This shows lack of a real ambition in tackling the sleeping giant of the energy transition, the heating sector. Even though heating is a national competence and therefore subject to subsidiarity, a stronger signal from the European level will be needed to push Member States to act promptly at national and even more at local level. Therefore, we ask for a mandatory target of 1,3pp for renewables to be included in the revision. Dedicated support for RES deployment in rural areas will be needed, especially with the promotion of on-farm renewables and with provisions to support the better mobilisation and handling of agricultural residues and by-products.

The REDIII also presents several opportunities for getting away from fossil energy in industry and districts. Industry accounts for more than one fourth of the European final energy consumption but renewables represent only 14% of the energy use in this sector. Bioenergy covers almost the entire renewable share for industrial process heat and can supply medium to high temperatures for a wide range of uses. Another

key segment is district heating, which despite the diversification of fuels and the growth of bioenergy is still heavily reliant on fossils. In 2019, renewables in district networks represented 27,6%, with bioenergy experiencing a threefold increase since 2000. These trends can continue if the FF55 sets an adequate policy framework and provides adequate support for these solutions. Agrobiomass district heating networks and bioheat coming from agro-industrial processes must be further promoted, as they are effective tools in triggering fuel switching and are the best examples of sector integration in rural areas.

8.2. Energy Efficiency Directive (EED)

The proposal for the revision of the Energy Efficiency Directive (EED) is also in progress. The new focus on heating decarbonisation and energy poverty issues is particularly relevant to achieving thriving rural areas. The higher energy efficiency target is also an important step towards the 2050 goal, and this must be mutually reinforced with further renewables penetration. This objective will only be achieved with the active contribution of renewable heat sources on-farm and nearby, and the relevance of agrobiomass solutions should be acknowledged to prioritise the decarbonisation of the heat sector in these areas. Therefore, a new definition of *renewable heat* must be included in Art.2 of the EED. This will actively promote sustainable heat options like bioenergy especially in the form of agrobiomass.

The EED proposal also stresses the need to modernise Europe's heating stock by listing a set of measures to support renewables uptakes and raise awareness on available solutions. This is still a major issue for the agrobiomass sector, where transparency and share of best practices is very much needed. More concrete actions, like the creation of knowledge-sharing platforms and the promotion of awareness raising campaigns on the benefits of agrobiomass must be implemented.

Finally, the EED suggests a new definition for *efficient district heating* in article 24. This new definition must be aligned with the circular economy and resource efficiency principle and ensure that agricultural residues already available and unused on-farm are utilised in the most efficient way, e.g. to produce renewable energy in the form of heat or combined heat and power. Agrobiomass must be the first preferred option to avoid locking-in fossil infrastructures and hindering the development of local solutions especially in the context of rural areas.

8.3. Energy Performance of Buildings Directive (EPBD)

Finally, the Energy Performance of Buildings Directive (EPBD) has a big potential for fostering the development of agrobiomass. According to the European Commission, buildings represent 40% of the EU's energy consumption, and are responsible for 36% of GHG emissions given that most of their energy is still produced from fossil fuels. Thus, particular attention must be given to on-site and nearby renewable heat sources in this context.

On top of this, the heating stock in Europe is increasingly old, with almost 25% of the appliances installed before 1992. The current annual replacement rate of old heating systems is not ambitious enough to achieve Europe's renewed targets.[11] This means that, without taking active measures at EU and national

[11] Ecofys (2016) Final report "EU pathways to a decarbonised building sector" How replacing inefficient heating systems can help reach the EU climate ambitions.

level, several old and inefficient appliances will still be operational (and polluting) in 2050. This is particularly relevant for rural areas, where fewer solutions are available whilst agriculture residues and local biomass are widely accessible. We therefore call for a minimum replacement target of at least 3 percentage points per year, combined with an obligation to replace or thoroughly retrofit installations older than 30 years. This measure would allow for the replacement of one third of the heating systems over the next ten years and remove any equipment installed before 1992 from the market.

The modernisation of old heating systems and the replacement of fossil fuels with renewable energy are pivotal to achieving Europe's decarbonisation goals as they will improve air quality and increase resource and energy efficiency. Using agrobiomass solutions will also ensure that residues are handled correctly and not burned on field inefficiently.

However, such change should not come at the expense of Europe's citizens and businesses. Energy poverty risks should be considered to avoid making the energy transition a burden for EU consumers: the obligation to replace old systems should be backed by adequate funding. Potential subsidies must include investments in rural development and must promote on-site and nearby renewable solutions.

8.4. Repower Europe plan (REPowerEU)

On top of the Fit for 55, the EU also recently published the REPowerEU strategy to get away from its dependency on Russian fossil fuels and accelerate Europe's clean energy transition. The first Communication published in March 2022 completely overlooked the bioenergy sector, looking only at its biomethane potential. The Communication was afterward followed by an updated plan where bioenergy was acknowledged as being the main renewable sources in Europe (accounting for 60% of the RES mix), but still lacked concrete targets and objectives.

With the Commission failing to consider bioenergy properly, the EU is missing a huge opportunity to ensure energy security and supply European citizens with renewable heat at an affordable cost next winter. Considering only biomethane in the plan represents just one fraction of the vast range of supply and potential of this sector which includes feedstock from forests, agriculture, and residues and waste management from several industries

Given the local dimension of biomass and agrobiomass, and the current energy prices, it's unacceptable for the EU to not properly consider this sector. The volatility of gas and electricity prices is not a problem for the bioenergy market, which in recent months has experienced a slight increase in costs due to a much higher demand. The bioenergy industry is highly diversified and therefore, a more holistic approach towards the sector is therefore needed. During the past few years, bioenergy has become more competitive, and it will continue growing in Europe across all sectors: power production, industry, transport, agriculture, and heating to name a few.

In addition, there is unlocked potential for underutilised biomass which is particularly relevant for agrobiomass**.** Residues from agricultural industry, rural and forest management, etc. should be cost-effectively utilised to produce renewable energy instead of being left to rot on the ground or burned in uncontrolled open-field fires.

9. Final Policy Recommendations

#1 Develop ad hoc plans for the promotion of non-woody biomass

To build on local needs and create tailored policies for non-woody biomass, ad hoc plans must be developed. This can be done with an update of the NECPs, and by placing additional focus on agrobiomass to identify national and local champions and to further replicate best practices and success stories.

Stronger requirements to promote heat planning for all municipalities will be needed to ensure that the right level of ambition is fulfilled. In this context, local authorities are expected to have a key role in assessing the needs and opportunities of their rural communities, and to promote the development of agrobiomass strategies with the support of concrete cases and regional *champions.*

#2 Extending the ban on field burning to all agricultural residues

GAEC 3 in the CAP places a ban on burning arable stubble. Extending this requirement has the potential to increase the residues available for bioenergy with the limits of maintaining organic matter as explicitly mentioned in GAEC 3. This objective has been recognised as having a direct impact on climate change mitigation and an indirect impact on farmland biodiversity, soil functionality, climate change adaptation and resilience to fire. Therefore, we call for an extension of the existing ban to all agricultural residues.

While this GAEC is being maintained, limiting the ban to only stubbles, instead of extending it to all the agricultural residues, will be a missed opportunity. Open field fires dramatically increase uncontrolled emissions and prevent the proper development of a sound agrobiomass sector. Stronger legislation at EU level can incentivise this switch by reducing open field burning and promoting alternative treatment methods, to further include rural areas in the energy transition.

#3 Promote investments in support of modern biomass appliances

EU legislation must support further investments in modern biomass appliances. On-site and nearby renewable sources can streamline investments in agrobiomass heating on-farm and in small district heating network in rural areas.

More investments in renewable heat solutions should be unlocked. Yet, to do so, investors and businesses need a minimum level of trust in the legal system. If the regulatory environment is constantly changing, it will discourage investments and long-term planning due to an elevated levels of uncertainty and risk. Retroactive measures, such as the one proposed in the REDIII revision draft, should always be avoided since they will hinder the development of a flourishing sector the likes of sustainable bioenergy.

#4 Streamline energy and agricultural strategy and regulations regarding energy crops

Specific EU legislation, such as the CAP, will play an important role in helping deliver the Green Deal's objectives, and will be an essential policy lever to steer the transformation of the EU's rural areas toward more sustainable pathways. The greater flexibility given to EU countries should promote adequate practices to support local needs and encourage a better mobilisation of agrobiomass sources to boost the switch from fossil energy to renewable solutions.

The potential of SRC and perennial energy crops should be boosted through dedicated policies. Perennial grasses, like switchgrass, can provide runoff protection as buffer strips along streams and rivers to keep nutrients out of waterways and lakes, thus providing dual benefits.[12] Well-managed switchgrass plots could extend the useful life of croplands which are no longer fit for typical row crop production. According to the Commission's impact assessment on the 2030 target, "biodiversity impact can be positive when replacing existing croplands, with woody biomass typically having fewer negative impacts".

#5 Reduce VAT on biomass fuels

The 2050 goals will not become a reality without the phase-out of fossil fuels from Europe's energy system, starting with the heating sector. The latter can lead to a substantial decrease in pollutant emissions, better air quality and the achievement of our energy and climate goals, while keeping in mind the environmental, societal, and economic benefits of sustainable solutions such as agrobiomass.

To further promote agrobiomass and other biomass fuels, the EU must reduce its taxation. A lower VAT would make agrobiomass systems more attractive and would incentive farmers and rural communities to switch away from fossil energy and embrace the renewable transition. Third parties should also be pushed to invest in biomass boilers that can serve multiple buildings in a given rural area, thereby creating new economies of scale that will lower heating costs than the replaced fuel and maintain profitability to cover the investment.

[12] https://www.intechopen.com/books/biofuels-status-and-perspective/enhancing-biomass-utilization-for-bioenergy-crop-rotation-systems-and-alternative-conversion-process

Annex I – Areas dedicated to lignocellulosic energy crops in the EU

Due to the lack of official statistics, Bioenergy Europe has developed its own data collection methodology and process for land areas cultivated by perennial energy crops. The figures are either extracted from the National Renewable Action Plan Progress Reports (2015-2016) or, when no official data were available, they were collected from market-based estimations or companies' questionnaires.

Additionally, few of them (for the total of grassy energy crops) are from Eurostat. The data collection focuses on lignocellulosic crops and excludes to the extent that is possible oil, sugar and starch crops grown for energy purposes.

Table 2 Surfaces cultivated with lignocellulosic energy crops. Source: Bioenergy Europe 2020

Country	Short Rotation Coppice (SRC)				Grassy energy crops			Total	Year	Sources
	Poplar	Willow	Other SRC	Total	Miscanthus	Other	Total			
EU28	**20.691**	**19.378**	**1.020**	**68.287**	**24.620**	**12.097**	**53.494**	**125.179**		
AT	977	244		**1.221**	1.078	52	**1.130**	**2.351**	2016	NREAP, Eurostat
BE		68	97	**165**	105	85	**190**	**355**	2012	NREAP
BG						3.286	**3.286**	**3.286**	2016	NREAP
CY								**0**	2016	NREAP
CZ	2.869			**2.869**	200	190	**390**	**3.259**	2016	NREAP, BEECO and Eurostat
DE				**6.600**	4.600	4.600	**9.200**	**15.800**	2016	NREAP, Eurostat
DK				**8.896**			**66**	**8.962**	2016	NREAP
EE	n.a.	n.a.	n.a.	**n.a.**	n.a.	n.a.	**n.a.**	**n.a.**		
EL							**11.010**	**11.010**	2016	Eurostat
ES							**38**	**38**	2018	CEDER
FI				**26**			**5.452**	**5.478**	2016	NREAP
FR				**220**	6.403		**6.403**	**6.623**	2019	ADEME, France miscanthus
HR					500		**500**	**500**	2016	NREAP
HU	3.352	505	247	**4.104**	1.000		**1.000**	**5.104**	2016	NREAP, BEECO
IE		1.100		**1.100**	700	410	**1.110**	**2.210**	2016	Teagasc
IT					1.000		**1.000**	**1.000**	2016	BEECO
LT				**4.063**			**0**	**4.063**	2016	NREAP
LU				**0**			**211**	**211**	2016	NREAP
LV	221	442	3	**666**		253	**253**	**919**	2018	Latbio
MT							**0**	**0**	2016	NREAP

Country	Short Rotation Coppice (SRC)				Grassy energy crops			Total	Year	Sources
	Poplar	Willow	Other SRC	Total	Miscanthus	Other	Total			
NL				**13**	245		**245**	**258**	2016	NREAP
PL	9.000	7.832		**16.832**	992		**992**	**17.824**	2016-2018	Polbiom
PT	n.a.	n.a.	n.a.	**n.a.**	n.a.	n.a.	**n.a.**	**n.a**		
RO[13]	2.600	600		**3.200**	600	2.530	**3.130**	**6.330**	2016	NREAP, Eurostat
SE	1.672	8.587	673	**10.932**		691	**691**	**11.623**	2016	NREAP
SI					400		**400**	**400**	2016	BEECO
SK					200		**200**	**200**	2016	BEECO
UK				**3.000**	10.000		**10.000**	**13.000**	2016	DEFRA
UA	175	4.200[14]		**4.375**	1.500		**1.500**	**5.875**	2018	BEECO

It is relevant to stress that figures are not always available, hence this table does not strictly reflect the field reality and is probably still underestimating the area dedicated to energy crops. Indeed, when just a part of the culture is dedicated for energy usage - when the crops are not registered as “dedicated” energy crops when it is plantations with several final uses (e.g. Eucalyptus in Spain) - statistics are even more complicated to get. This division issue is also related to policy decisions regarding financial supports.

[13] Additional 5,500 hectares of giant reed
[14] Ukraine's Progress Report On The Promotion And Use Of Energy From Renewable Sources in Ukraine in the years of 2016-2017 https://www.energy-community.org/documents/reports.html

Annex II – EU27 tables

Table 3 Heating and cooling consumption in the EU27 Member states. Source: Eurostat

2020	Total H&C consumption	Renewables H&C consumption	Share of renewables	Bioheat consumption	Share of bioheat in the renewable H&C mix
EU27	452.996,8	104.589,7	23%	87.819,9	84%
AT	13.388,9	4.685,5	35%	4.096,5	87%
BE	17.647,3	1.490,6	8%	1.330,8	89%
BG	4.098,2	1.523,6	37%	1.348,9	89%
CY	530,9	197,1	37%	75,6	38%
CZ	13.943,7	3.281,6	24%	3.029,0	92%
DE	106.971,0	15.839,4	15%	13.611,3	86%
DK	7.218,9	3.686,9	51%	2.982,2	81%
EE	1.504,2	870,9	58%	783,2	90%
EL	5.030,3	1.606,7	32%	842,0	52%
ES	28.255,0	5.076,4	18%	3.785,3	75%
FI	13.344,0	7.689,1	58%	7.168,4	93%
FR	58.076,5	13.571,6	23%	9.891,1	73%
HR	3.244,3	1.198,1	37%	1.162,8	97%
HU	10.226,7	1.812,2	18%	1.654,0	91%
IE	4.906,0	307,3	6%	236,1	77%
IT	52.023,2	10.378,3	20%	7.529,5	73%
LT	2.376,4	1.196,5	50%	1.173,8	98%
LU	1.097,8	138,5	13%	129,1	93%
LV	2.288,3	1.306,5	57%	1.309,6	100%
MT	95,0	21,9	23%	2,8	13%
NL	25.069,4	2.018,8	8%	1.471,8	73%
PL	38.416,5	8.506,7	22%	8.104,0	95%
PT	6.174,0	2.565,1	42%	1.841,1	72%
RO	13.640,4	3.454,6	25%	3.441,9	100%
SE	15.729,6	10.441,5	66%	9.227,6	88%
SI	1.797,1	577,6	32%	509,6	88%
SK	5.902,9	1.146,7	19%	1.081,9	94%

Table 4 Share of population depending on the degree of urbanisation in EU27 Member states. Source: Eurostat

2020	Cities	Towns and suburbs	Rural areas
EU27	39,5	30,4	30,1
AT	30,9	31,0	38,1
BE	30,0	54,8	15,3
BG	44,8	23,9	31,3
CZ	59,6	23,0	17,4
CY	30,3	33,2	36,5
DE	39,0	41,4	19,6
DK	37,2	30,0	32,8
EE	60,4	9,3	30,3
EL	36,4	31,7	31,9
ES	50,6	23,4	26,0
FI	39,5	31,5	29,0
FR	37,6	28,0	34,4
HR	29,8	33,7	36,5
HU	32,0	35,7	32,3
IE	35,2	25,3	39,5
IT	35,7	46,1	18,3
LT	42,1	13,0	44,9
LU	19,1	48,0	32,9
LV	43,3	18,9	37,8
MT	88,8	11,1	0,2
NL	56,0	33,4	10,7
PL	34,4	24,3	41,3
PT	45,3	30,6	24,1
RO	29,4	27,8	42,8
SE	39,5	41,2	19,4
SI	19,2	36,1	44,7
SK	21,4	34,7	43,9

Annex III – Agrobiomass heating prospects in France

Major facts on bioenergy state of the art in the country

In 2020, the Gross Inland Consumption from biomass (in all its forms) in France reached 15.214 ktoe representing around 6,8% of the total Gross inland consumption from all fuels for the country. If we focus on the Final Energy Consumption (FEC) in 2020, Bioenergy accounted for 10.973 ktoe representing 8,55% of the total FEC of the country. If we break down the FEC of biomass by fuels we notice that solid biomass (woody and agrobiomass) represents around 70,5% of the mix, followed by blended biodiesels (21,5%). The rest is composed mainly of blended biogasoline, biogases and renewable municipal waste.

When focusing on the sectoral utilisation of solid biomass only (Forest and agricultural biomass) as can be seen on Figure 8, 100% of it is divided between the industry (with all its sub sectors like construction, iron and steel, chemicals, etc.), Agriculture & forestry, Commercial and public services, and finally Domestic use of solid biomass.

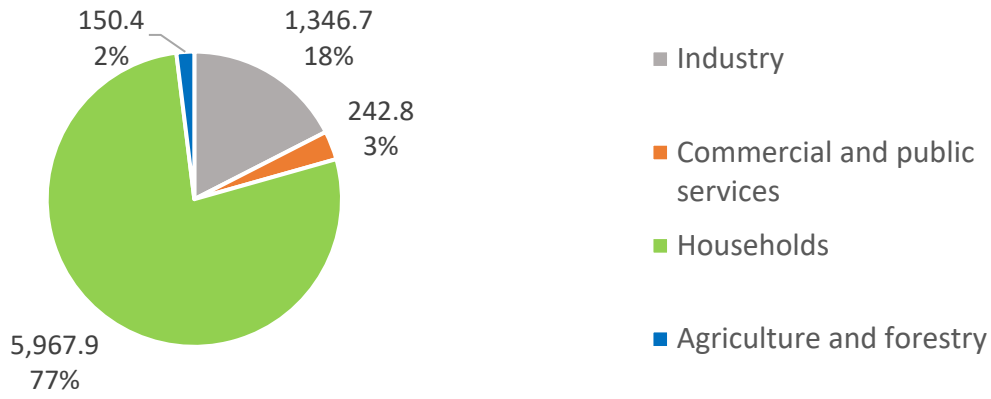

Figure 8 Breakdown of the final energy consumption of primary solid biofuel per end-use sector in France in 2020. Source: Eurostat

Figure 9 illustrates the evolution of the FEC of solid biomass in the last 20 years across all sectors as well as to cover households' energy needs. We can see on the figure that the main driver of the total FEC is household consumption, but this could be expected considering the fact that households are by far the largest solid biomass consumers.

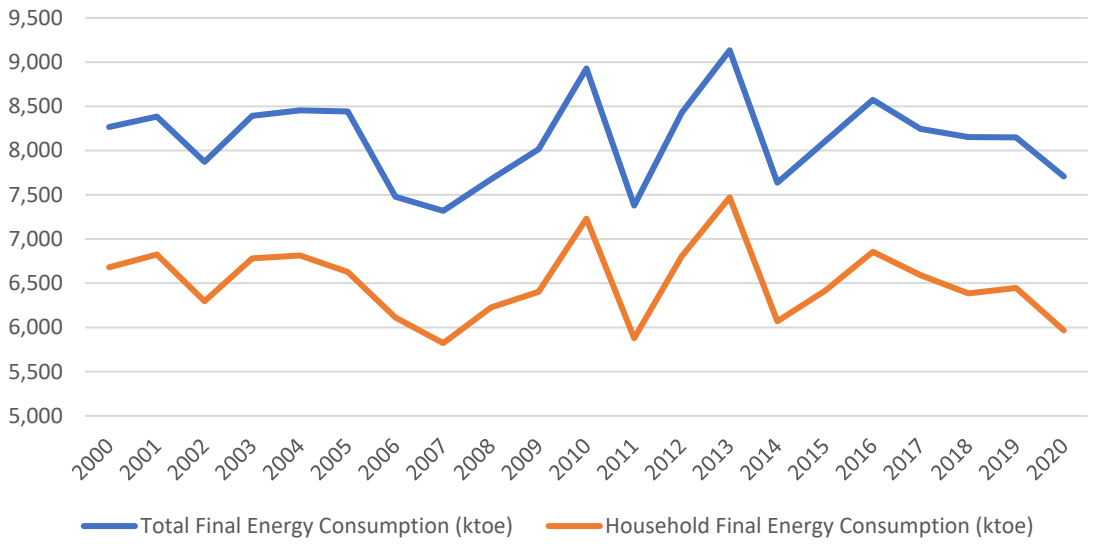

Figure 9 Evolution of the total Final Energy Consumption of solid biomass and Household Final Energy Consumption of solid biomass in France in ktoe. Source: Eurostat

Figure 10 represents the evolution of the share of solid biomass consumed by households for the last 20 years out of the total solid biomass consumed for energy. We notice a small drop in the share of solid biomass consumed by households, going from 81% in the beginning of the century to 77% in 2020.

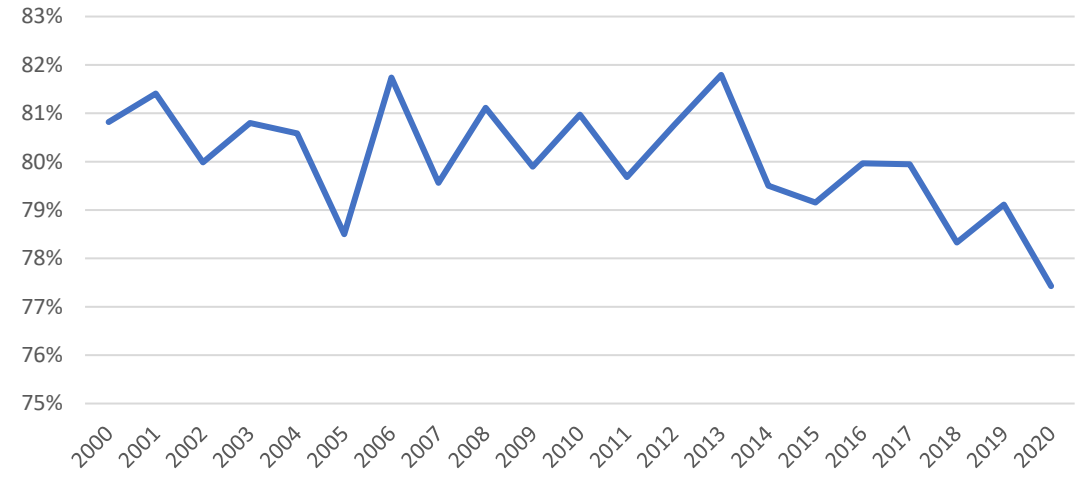

Figure 10 Evolution of the share of the Final Energy Consumption of solid biomass consumed in households out of the total solid biomass consumption for energy in France. Source: Eurostat

Agrobiomass state of play in the country

Out of the EU27 in 2019, France is the country with the largest Cropland area, which can be defined as the total agricultural land from which we deduct the area dedicated to animal husbandry. In fact, with its 19.075.400 hectares, it largely dominates the rest of Europe, whose second largest country in terms of cultivated area is Spain with almost 17 million hectares. This French agricultural surface represents 35% of the total land area of the country, placing France in the sixth position in terms of relative amount.

Given its position as European leader in agriculture, France is an extremely promising country for the use of agrobiomass for energy production because of its potential to generate a lot of residues and waste that can be recovered.

An independent study commissioned by CONCAWE in August 2021 (Panoutsou & Maniatis, 2021) focused on the amount of sustainable biomass available in 2030 and 2050 under different scenarios. There are three scenarios, depending on the intensity with which biomass is mobilised. Focusing on the median scenario, referred to as "improved mobilisation in selected countries", the assumptions of this model are the following:

- Improved management practices in i) agriculture such as crop rotation, cover crops, agroforestry, etc. which can improve soil and increase biomass productivity and ii) forestry such as improved harvesting techniques, fertilization (where possible), storage and transport optimization, etc.
- Significant parts (50%) of unused, abandoned, and degraded land are used for biomass crops.
- Emphasis remains on the use of residues and wastes in the energy and non-energy biobased sectors.
- Biodiversity is included in the estimated potentials accounting for: i) conservation of land with significant biodiversity values (direct and indirect), and ii) land management without negative effects on biodiversity

It emerges from this report that the potential in sustainable agrobiomass in France for energy production (Quantity available for all markets from which we subtract the non-energy demand) in 2030 is extremely high. The breakdown per type of agricultural feedstock can be found in Table 5.

Table 5 2030 Bioenergy potential per type of agricultural feedstock in Mtoe in France. Source: (Panoutsou & Maniatis, 2021)

Type of Agrobiomass	2030 Bioenergy Potential (Mtoe)
Cereal straw	9.95
Maize stover	2.19
Oil crop field residues	1.85
Agricultural pruning	0.06
Manure	2.32
Secondary Agricultural residues	6.34
Lignocellulosic crops	2.65
Total	**25.36**

If we compare this potential to the final energy consumption in French households for the whole year 2020, we can see that it could theoretically be possible to provide 65,5% of the final energy consumption of households, all fuels included, whether they are fossil fuels or renewables (as a reminder, the final energy consumption in households in 2020 is 38,71 Mtoe).

Figure 11 illustrates the current distribution of the different fuels covering the heating needs of French households. It can be seen on this graph that solid biomass already holds an important place in the residential energy mix in France, but it is unfortunately difficult to estimate the share of agrobiomass in this category. Indeed, the pellet market is particularly well developed in the country, and it is more than likely that the vast majority of this biomass is forest-based and not agricultural. However, the agrobiomass transformed in the form of agropellets constitutes a non-negligible opportunity in light of the number of boilers and pellet stoves already installed in France.

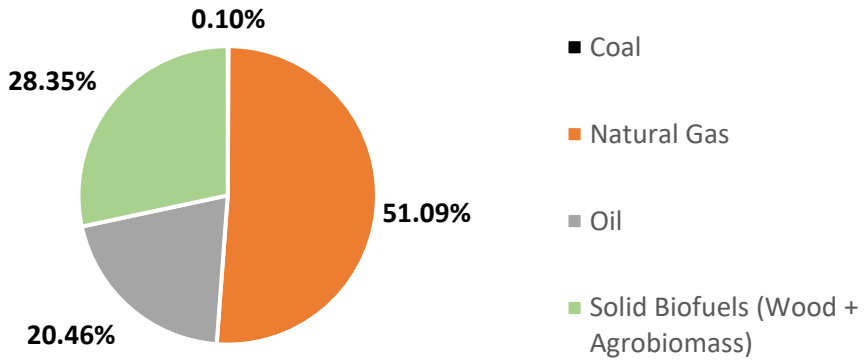

Figure 11 Fuel consumption for residential heat in 2020 in France. Source: Eurostat

If we now focus on the commercial/utility sector, it is clear that solid biomass is much less important than in the residential sector (about 3,5% compared to almost 30% in the domestic sector). This is most likely due to past incentives that have steered the development of this sector towards other types of facilities, mainly natural gas (67,12%) or other petroleum products (29,41%). Coal still occupies a very small place in the mix (less than 0,5%), but this still represents a market share that can be replaced by biomass installations.

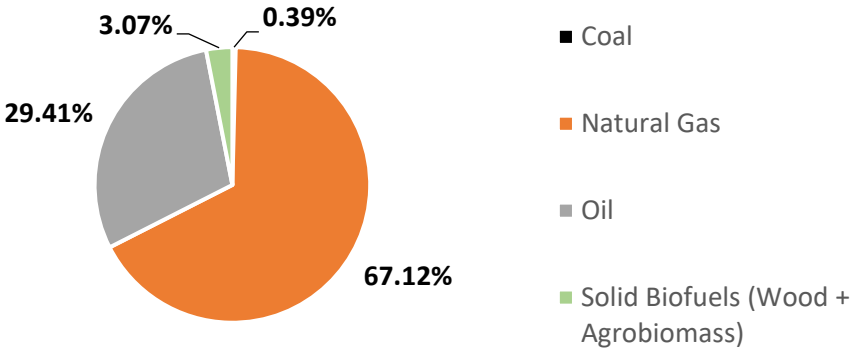

Figure 12 Fuel consumption for commercial/public services sector in France in 2020. Source: Eurostat

Finally, a last sector of interest if one wishes to cover the totality of heating needs is that of decentralised heating. Indeed, Figure 13 shows that, unlike the commercial sector, solid biomass and its other forms (liquid, gaseous) represent an equally important share as natural gas, i.e. 47,52% versus 48,89% respectively. There is also still a significant portion of coal that could be replaced by biomass and thus allow it to represent the majority of fuels used in district heating systems.

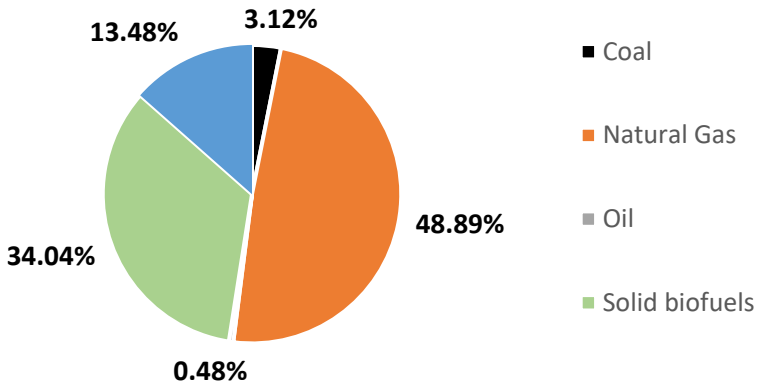

Figure 13 Fuel consumption for derived heat in France in 2020. Source: Eurostat

Annex IV – Agrobiomass heating prospects in Austria

Major facts on bioenergy state of the art in the country

In 2020, the Gross Inland Consumption from biomass (in all its forms) in Austria reached 5.506 ktoe representing around 17% of the total Gross inland consumption from all fuels for the country. If we focus on the Final Energy Consumption in 2020, Bioenergy accounted for 3.475,6 ktoe representing 14% of the total Final Energy Consumption of the country. If we break down the final energy consumption of biomass by fuel, we notice that solid biomass (woody and agrobiomass) represents an outstanding 87% of the energy mix, followed by blended biodiesels (around 10%), and the remaining share is composed of charcoal, biogases, blended biogasoline and pure biodiesels.

When focusing on the sectoral utilisation of solid biomass as can be seen on Figure 14, it is divided between the industry (with all its sub sectors like construction, iron and steel, chemicals, etc.), Agriculture & forestry, Commercial and public services, and finally Domestic use of solid biomass.

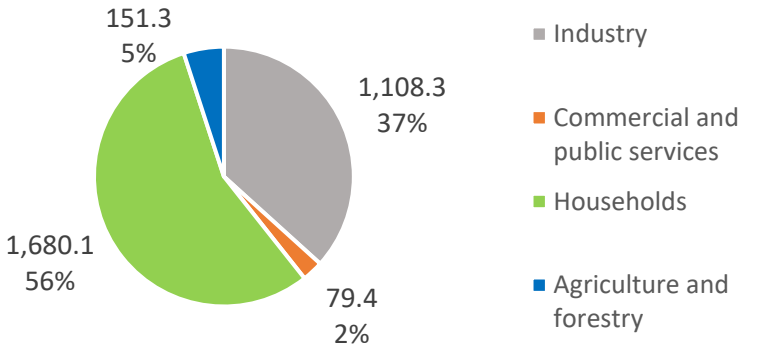

Figure 14 Breakdown of the final energy consumption of primary solid biofuel per end-use sector in Austria in 2020. Source: Eurostat

Figure 15 illustrates the evolution of the FEC of solid biomass in the last 20 years across all sectors as well as to cover households' energy needs. We can see on the figure that the main driver of the total FEC is household consumption, but this could be expected considering the fact that households are by far the largest solid biomass consumers.

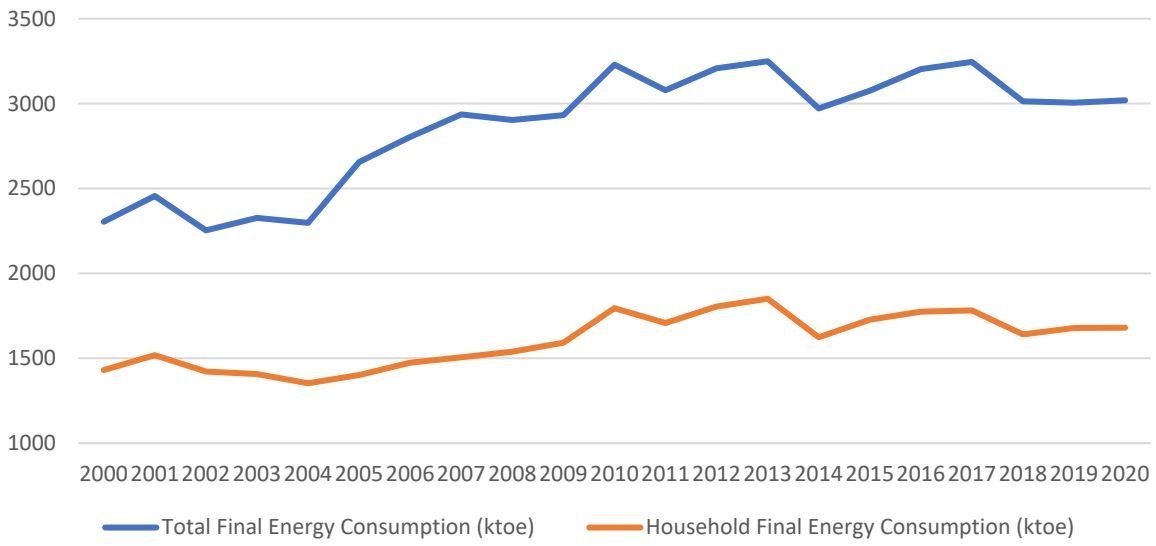

Figure 15 Evolution of the total Final Energy Consumption of solid biomass and Household Final Energy Consumption of solid biomass in Austria in ktoe. Source: Eurostat

Figure 16 shows the evolution of the share of solid biomass consumed by households for the last 20 years out of the total solid biomass consumed for energy. We notice a significant drop (around 12%) between 2002 and 2007 but the share has been quite stable since.

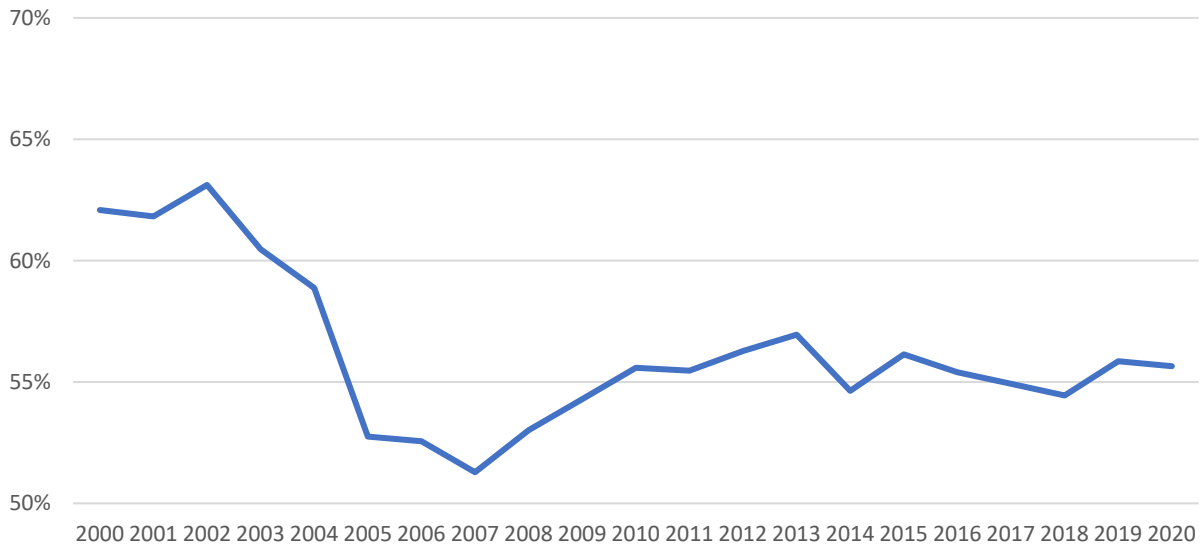

Figure 16 - Evolution of the share of the Final Energy Consumption of solid biomass consumed in households out of the total solid biomass consumption for energy in Austria. Source: Eurostat

Agrobiomass state of play in the country

Austria takes the 16th position in terms of Cropland area, with 1.392.400 ha dedicated to agricultural crop production. With a land area around 8.252.000 ha, cropland thus only represents a small 17% of the country's surface, putting Austria at the 20th position for the EU27. It is unfortunately relatively difficult to establish the current use of agrobiomass in European countries because there is no database available at the moment that puts together this type of information. Thanks to Eurostat, we know that solid biomass represents 86,87% of the final bioenergy consumption, but that category represents woody biomass as well as agrobiomass. In Austria, the wood pellet market is particularly well developed and growing, and it's thus safe to assume that most of this solid biomass is actually wood based and not agro based. In Table 6, it is possible to see an estimate of the agrobiomass potential for energy in 2030 according to a study carried out in 2021 (Panoutsou & Maniatis, 2021) for different types of agricultural feedstocks.

Table 6 2030 Bioenergy potential per type of agricultural feedstock in Mtoe in Austria. Source: (Panoutsou & Maniatis, 2021)

Type of Agrobiomass	2030 Bioenergy Potential (Mtoe)
Cereal straw	0,66
Maize stover	0,26
Oil crop field residues	0,07
Agricultural pruning	0,02
Manure	0,11
Secondary Agricultural residues	4,67
Lignocellulosic crops	0,18
Total	5,97

If we compare this potential to the final energy consumption in Austrian households for the year 2020 (6,683 Mtoe) we can see that it could theoretically be possible to provide 89,3% of the total final energy consumption of households (renewables + non-renewables).

In order to assess the potential market penetration of agrobiomass in Austria, it is necessary to take a closer look at the heating sector, mainly residential. Indeed, agrobiomass represents a real interest for rural communities for which the supply of feedstock does not represent a substantial constraint. Figure 17 shows the different types of fuel used for residential heating and their respective proportions.

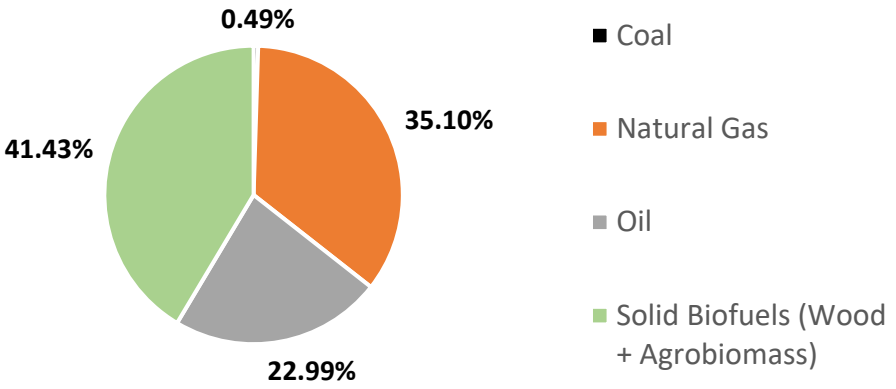

Figure 16 Fuel consumption for residential heat in 2020 in Austria. Source: Eurostat

We can see that almost half of the heating demand of Austria is currently covered by solid biofuels, composed of Wood and Agrobiomass (41,43%). With regard to other solid fuels, we can see that coal also plays a role in residential heating, but in extremely small proportions (less than 0,5%). However, these figures are encouraging for the future development of agrobiomass, thanks to the possibilities of adapting old coal installations to biomass installations at lower costs than total replacement.

For comparison purposes, Figure 18 shows the commercial/public service use of these same fuels. It can be seen that this sector relies much less on solid fuels and that the potential for adaptation of old installations is much lower.

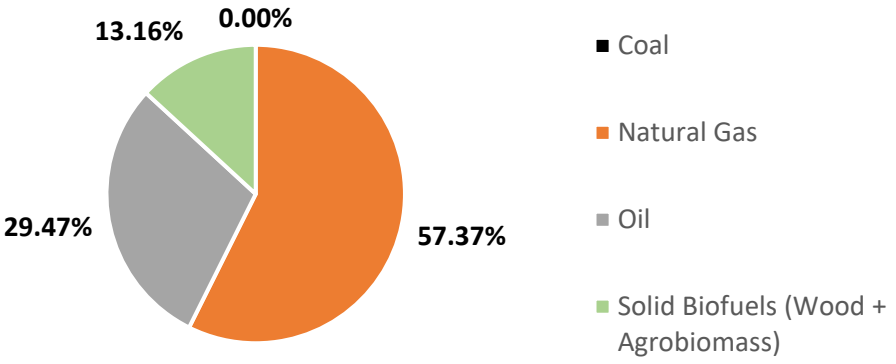

Figure 17 Fuel consumption in the commercial/public services sector in Austria in 2020. Source: Eurostat

Finally, it is now appropriate to look at a last sector of interest for agrobiomass: decentralised heat. Figure 19 shows the current proportion of fuels used in this "sector". Solid biomass represents the largest portion of decentralised heating systems, but that there is still room to increase this fraction. Indeed, some installations still use coal and are destined to be replaced. These can be converted to biomass systems, mainly in semi-rural areas, where the concentration of housing justifies decentralised systems, but also where the supply of raw materials is not an issue.

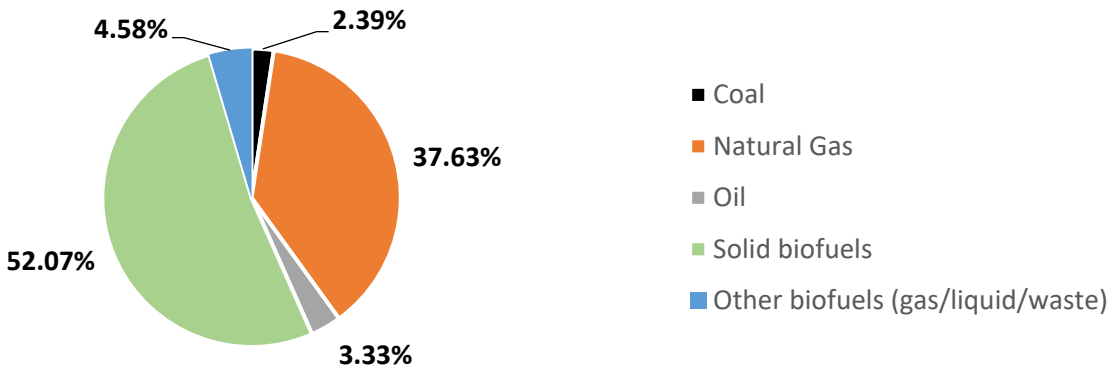

Figure 18 Fuel consumption for derived heat in Germany in 2020. Source: Eurostat

Annex V – Agrobiomass heating prospects in Germany

Major facts on bioenergy state of the art in the country

In 2020, the Gross Inland Consumption from biomass (in all of its forms) in Germany reached 27.330,6 ktoe representing around 9,6% of the total fuel consumption of the country. If we focus on the Final Energy Consumption in 2020, Bioenergy accounted for 15.098,8 ktoe representing 7,8% of the total Final Energy Consumption of the country. If we break down the Final Energy Consumption of biomass by fuel, we notice that solid biomass (woody and agrobiomass) represents 62,34% of the mix, followed by blended biodiesels (18,52%), biogases (9,45%), blended biogasoline (4,61%) and renewable municipal waste (3,84%) while charcoal, pure biodiesels and other liquid biofuels sum up to reach around 1,5%.

When focusing on the sectoral utilisation of solid biomass, all of it is divided between the industry (with all of its sub sectors like construction, iron and steel, chemicals, etc), Agriculture & forestry, Commercial and public services, and finally Domestic use of solid biomass.

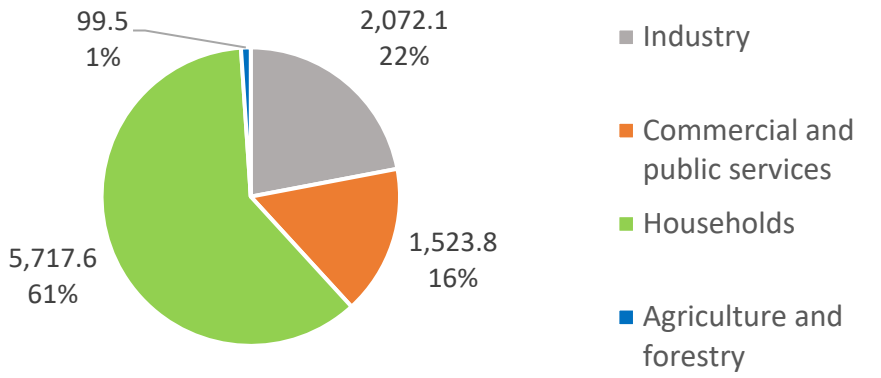

Figure 19 Breakdown of the final energy consumption of primary solid biofuel per end-use sector in Germany in 2020. Source: Eurostat

Figure 21 illustrates the evolution of the FEC of solid biomass in the last 20 years across all sectors as well as to cover households' energy needs. We can see on the figure that the main driver of the total FEC is still household consumption nowadays, but this trend was more pronounced before 2022 as can also be seen on figure 22.

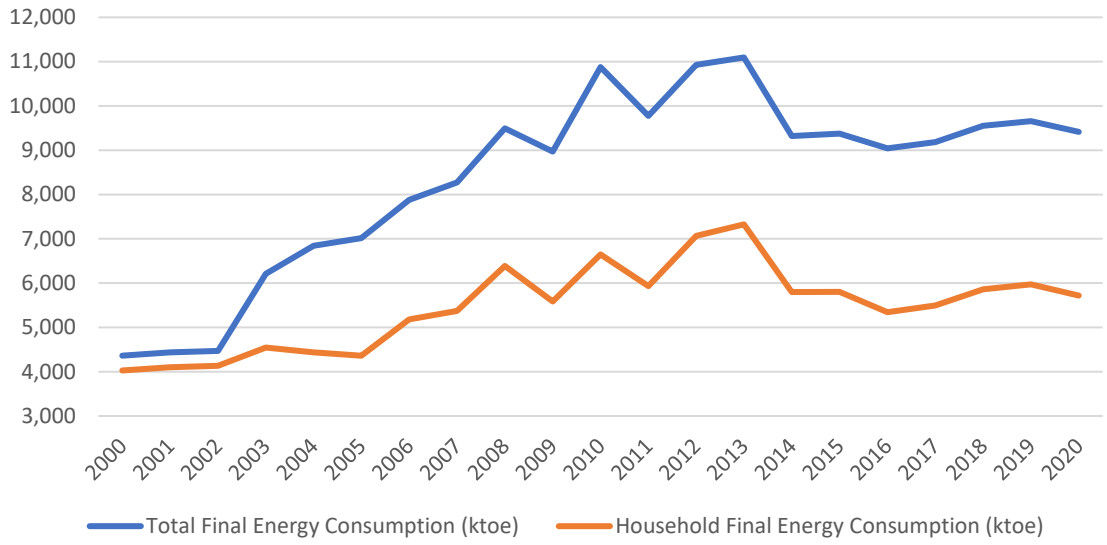

Figure 20 Evolution of the total Final Energy Consumption of solid biomass and Household Final Energy Consumption of solid biomass in Germany in ktoe. Source: Eurostat

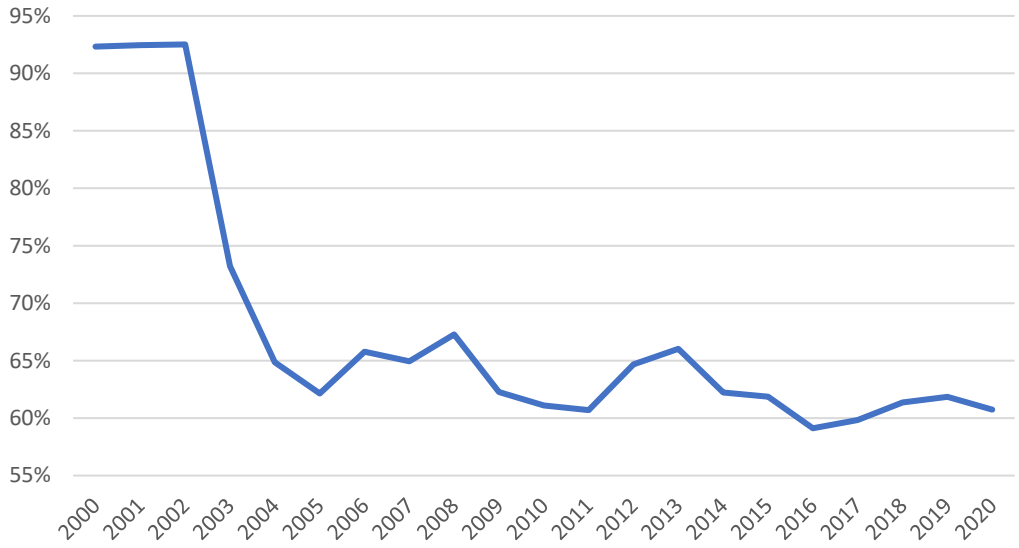

Figure 21 Evolution of the share of the Final Energy Consumption of solid biomass consumed in households out of the total solid biomass consumption for energy in Germany. Source: Eurostat

Agrobiomass state of play in the country

In the EU27, Germany ranks third in terms of the area dedicated to crops, with a total value of 11.913.000 ha. In terms of proportion, the country ranks seventh, with 34% of its land area dedicated to crops. The agricultural situation in Germany is quite similar to that of Poland in terms of absolute value of area (about 500.000 ha difference), but since Germany's area is larger, the country is surpassed by Poland in terms of percentages (34% versus 37%). Some agricultural productions are especially well developed in Germany, like hop for example, which is directly related to the country's quite important brewing sector. This sector is particularly promising in terms of agrobiomass because it produces a large quantity of valuable co-products during the brewing process.

Estimating the current consumption of agrobiomass is unfortunately very difficult, since Eurostat's database aggregates all solid biomass consumption under the category "Primary solid biofuels", whether they come from agriculture or forestry. However, when looking at the amount of agricultural production in Germany, it is not impossible that agricultural biomass occupies a significant portion (although less than the more widely used forest biomass) of the solid biomass mix. In Table 7, it is possible to see an estimate of the agrobiomass potential for energy in 2030 according to a study carried out in 2021 (Panoutsou & Maniatis, 2021) for different types of agricultural feedstocks.

Table 7 2030 Bioenergy potential per type of agricultural feedstock in Mtoe in Germany. Source: (Panoutsou & Maniatis, 2021)

Type of Agrobiomass	2030 Bioenergy Potential (Mtoe)
Cereal straw	9,27
Maize stover	0,61
Oil crop field residues	0,02
Agricultural pruning	0,06
Manure	5,76
Secondary Agricultural residues	1,70
Lignocellulosic crops	2,00
Total	19,43

When we compare this potential with the total final energy consumption in households, the value of which reached 57,989 Mtoe in 2020, we notice that the agrobiomass bioenergy potential of 2030 could theoretically cover one third of the total final energy consumption in German households.

It is also interesting to analyse the residential market in further detail when discussing agrobiomass potential. Figure 23 illustrates the fuel consumption for heating in the residential sector in 2020 in Germany. This graph shows that the majority of German households rely on the use of natural gas for heating. Solid biomass represents 14% of the residential market. This portion could well increase due to the rise in energy prices in 2021 as well as the complicated geopolitical situation which decreases the attractiveness of certain fuels, especially natural gas.

This graph also shows that a very small proportion of households still use coal for heating. In order to reduce greenhouse gas emissions, these coal-fired boilers are destined to be replaced and this represents a considerable opportunity for biomass to retrofit these installations at more bearable costs for the less fortunate households.

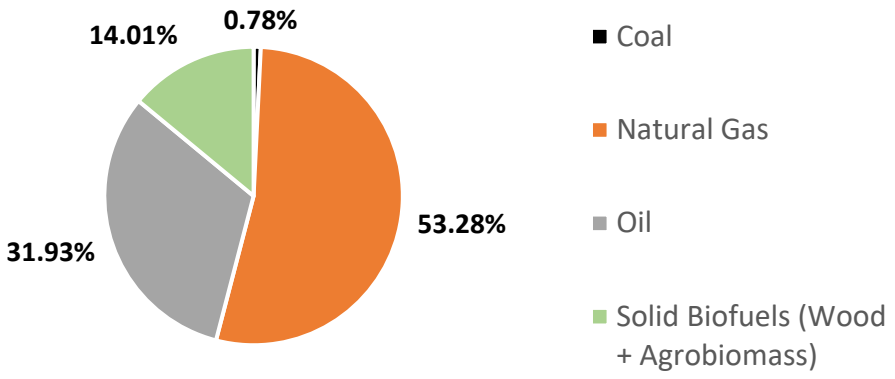

Figure 22 Fuel consumption for residential heat in 2020 in Germany. Source: Eurostat

For the sake of comparison, Figure 24 also represents the consumption of different fuels but this time in the commercial/utility sector. It is clear that the proportion of biomass in these sectors is lower than in the residential sector. This may be due to several factors, such as the use of decentralised gas heating systems (district heating) or a more difficult access to feedstocks than in rural areas.

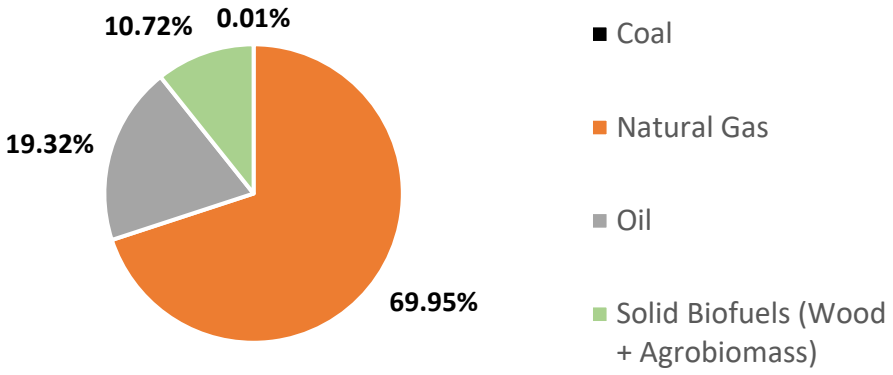

Figure 23 Fuel consumption for commercial/public services sector in Germany in 2020. Source: Eurostat

Finally, a last sector that should be analysed when exploring the potential of agrobiomass is the decentralised heating sector. Figure 25 shows that almost a quarter of the heat produced by these systems is coal dependent, which is a major potential market for biomass in general, and for agrobiomass if conditions are favourable.

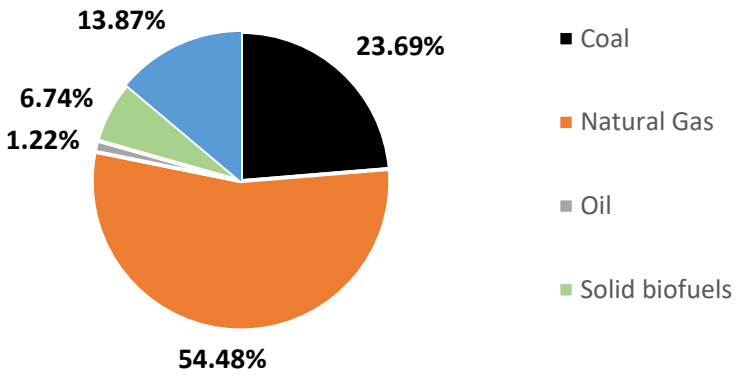

Figure 24 Fuel consumption for derived heat in Germany in 2020. Source: Eurostat

Annex VI – Agrobiomass heating prospects in Poland

Major facts on bioenergy state of the art in the country

In Poland in 2020, the Gross Inland Consumption (GIC) of biomass represented 10.837 ktoe, or approximately 10,52% of the country's total GIC. When focusing on the Final Energy Consumption (FEC) in 2020, Bioenergy accounted for 8.637 ktoe representing around 12,3% of the country's Final Energy Consumption. If we look more into details on the contribution of each biomass fuel to the FEC of bioenergy, we notice that solid biomass represents 86,22% of the mix, followed by blended biodiesels (9,69%) and blended biogasoline (2,12%). The rest is composed of biogases and renewable municipal waste representing a bit under 2%.

Regarding the sectoral utilisation of solid biomass, Household consumption for heating takes the lead and represents 65% of the total use. A majority of the remaining solid biomass, more precisely 26%, is directed towards industrial uses. Paper, pulp & printing and Wood & wood products represent 49,8% and 42,8% of the industrial consumption, respectively.

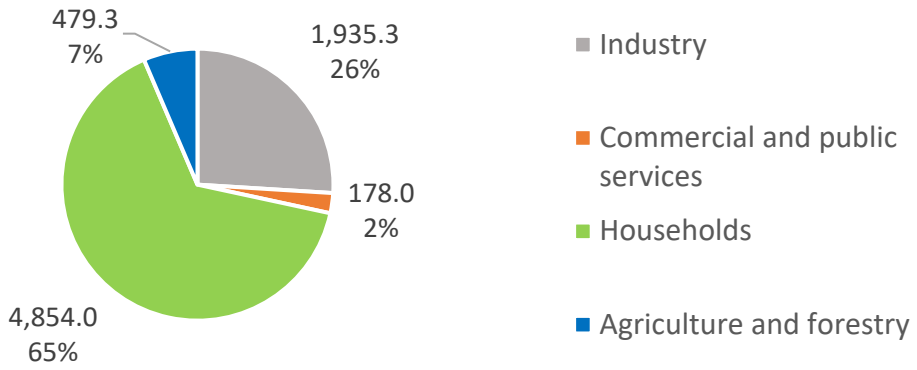

Figure 25 Breakdown of the final energy consumption of primary solid biofuel per end-use sector in Poland in 2020

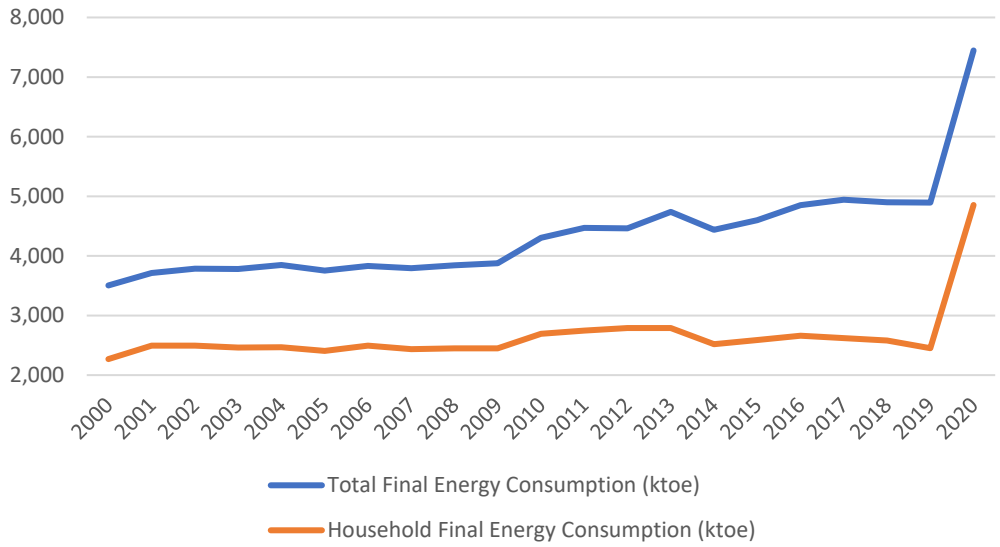

Figure 26 Evolution of the total Final Energy Consumption of solid biomass and Household Final Energy Consumption of solid biomass in Poland in ktoe. Source: Eurostat

Figure 27 represents the evolution of the FEC of solid biomass in the last 20 years across all sectors as well as to cover households' energy needs. We can see on the figure that the main driver of the total FEC is household consumption, but that trend was slowly decreasing until 2019. However, recent national incentives (like the clean air program for example) have allowed for a bigger share of solid biomass use in households in 2020 as can be seen in Figure 28, and it is likely that it will continue in the upcoming years.

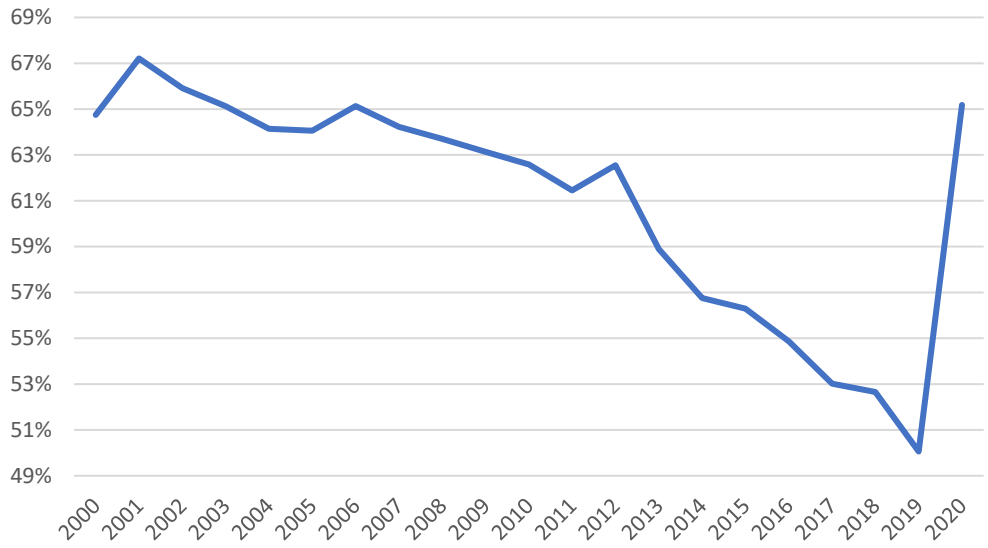

Figure 27 Evolution of the share of the Final Energy Consumption of solid biomass consumed in households out of the total solid biomass consumption for energy in Poland. Source: Eurostat

Agrobiomass state of play in the country

In terms of agriculture, Poland ranks fourth in Europe, both in terms of absolute area and as a percentage of the country's total area. In fact, some 11.395.000 ha are dedicated to Croplands, which represents 37% of the total area of the country. However, only 3% of this Cropland area is covered by permanent crops. This value is fairly low, but when we consider the European scale, we can realize that the median ratio of coverage of permanent crops in comparison to the cropland area is only 4% for an average percentage of 9%. Poland alone represents more than 3/4 of the EU27 production of lupins, a plant mainly cultivated for its seeds which are used for animal feed and sometimes even for human consumption (however, not very widespread). As the agricultural sector is of considerable importance in Poland, the country is very promising in terms of development of the agrobiomass heating market. When looking at the bioenergy potential of different agrobiomass feedstocks coming from an independent study commissioned by CONCAWE in August 2021 (Panoutsou & Maniatis, 2021), we can see that Poland is one of the EU27 countries with the highest potential of Agrobiomass for energy use. This total potential, amounting to 15,38 Mtoe, ranks Poland fourth in terms of agrobiomass potential, which seems logical given that the country also ranks fourth in terms of Agriculture in 2020.

Table 8 2030 Bioenergy potential per type of agricultural feedstock in Mtoe in Poland. Source: (Panoutsou & Maniatis, 2021)

Type of Agrobiomass	2030 Bioenergy Potential (Mtoe)
Cereal straw	6,47
Maize stover	0,41
Oil crop field residues	0,50
Agricultural pruning	0,26
Manure	2,50
Secondary Agricultural residues	1,10
Lignocellulosic crops	4,14
Total	15,38

When we put into perspective the potential value with the current energy consumption of polish households (Final Energy Consumption in households in 2020: 21,101 Mtoe), we see that this potential could theoretically meet nearly 73% of the country's total household energy consumption for the year 2020, all fuels combined.

If we want to explore the residential sector in more detail, Figure 29 represents the energy mix for the heating needs of households in Poland. First of all, we can see that solid biomass (forestry and agricultural) currently occupies a prominent place in the mix (33,45%). However, another important element is the prevalence of coal for domestic heating in Poland. Indeed, with a share of 35,83%, it is the most consumed fuel, and this represents an enormous potential for biomass. Indeed, it is one of the solutions that allows a low-cost transformation of the installations using coal. Moreover, given the above-mentioned potential as well as the current agricultural production, the supply of feedstock does not seem to be a problem in Poland.

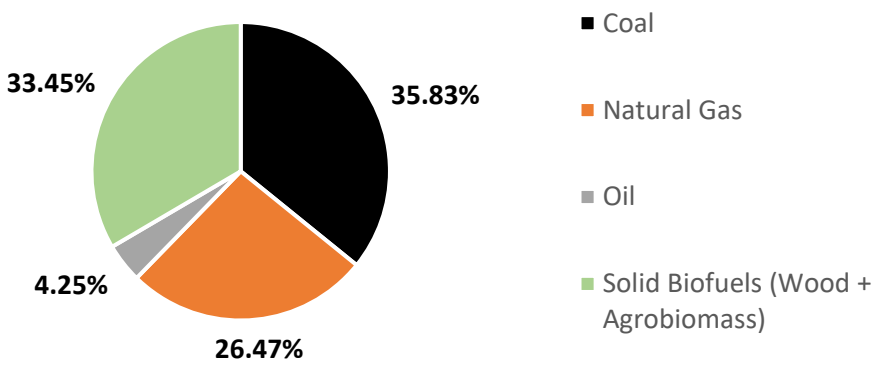

Figure 28 Fuel consumption for residential heat in 2020 in Poland. Source: Eurostat

Then, in the commercial and utilities sector (Figure 30), we note a relatively different trend, with natural gas dominating for heating needs. Biomass accounts for only a small portion (less than 10%), but we note again the important place occupied by coal. Indeed, coal accounts for a little less than a quarter of the mix (22,92%) and, as in the residential sector, this market share could be occupied by biomass and thus allow for the partial decarbonisation of this sector at reduced costs.

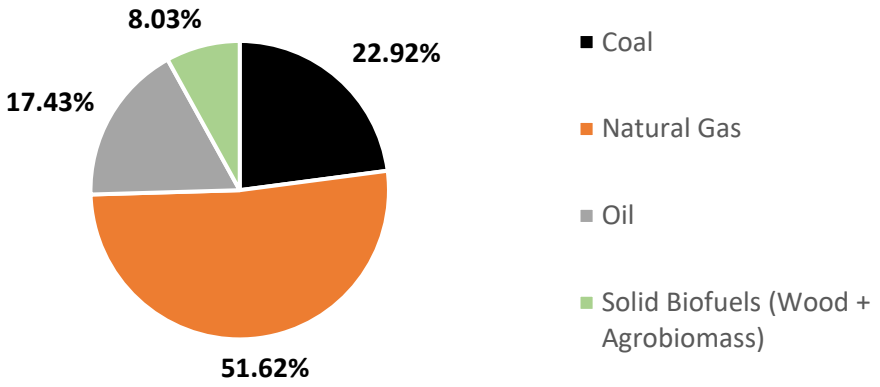

Figure 29 Fuel consumption for commercial/public services sector in Poland in 2020. Source: Eurostat

Finally, one last paramount point to cover when looking at heating systems is district heating. Figure 31 highlights the total dominance of coal for district heat generation. Indeed, biomass represents only about 7%, natural gas about 11% and coal about 80%. In the case of decentralised systems, the supply and storage of biomass is generally not a problem, especially in the case of Poland where the current installations are made to be supplied with coal (also requiring a lot of space to be stored). Thus, the future of biomass in decentralised systems seems to be promising, especially if the financing situation is positive towards this energy source.

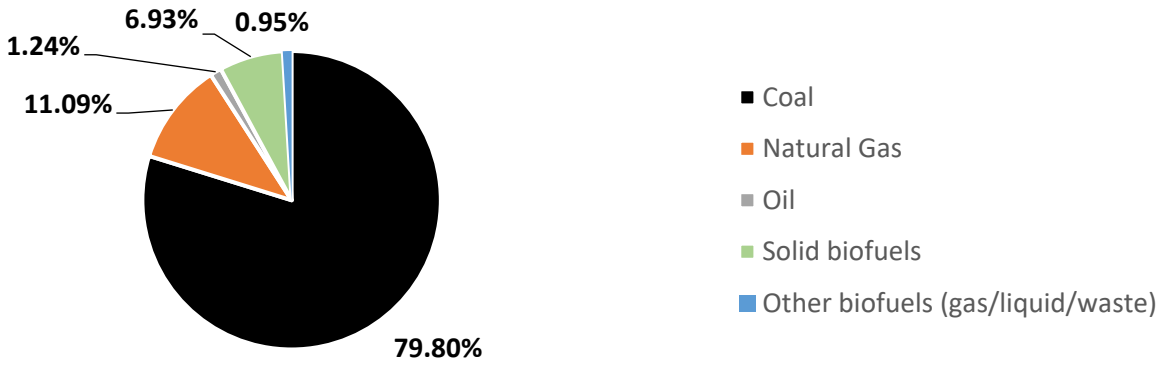

Figure 30 Fuel consumption for derived heat in Poland in 2020. Source: Eurostat

Annex VII – Agrobiomass heating prospects in Italy

Major facts on bioenergy state of the art in the country

In 2020, the Gross Inland Consumption from biomass (in all of its forms) in Italy reached 13.443 ktoe representing around 9,5% of the total fuel consumption of the country. If we focus on the Final Energy Consumption in 2020, Bioenergy accounted for 7.829 ktoe representing 7,6% of the total Final Energy Consumption of the country. If we break down the final energy consumption of biomass by fuel, we see that solid biomass (woody and agrobiomass) represents 82,55% of the mix, followed by blended biodiesels (15,9%) while charcoal, biogases and blended biogasoline sum up to represent around 1,5%.

When focusing on the sectoral utilisation of solid biomass, it is divided between the industry (with all of its sub sectors like construction, iron and steel, chemicals, etc), Agriculture & forestry, Commercial and public services, and finally Domestic use of solid biomass.

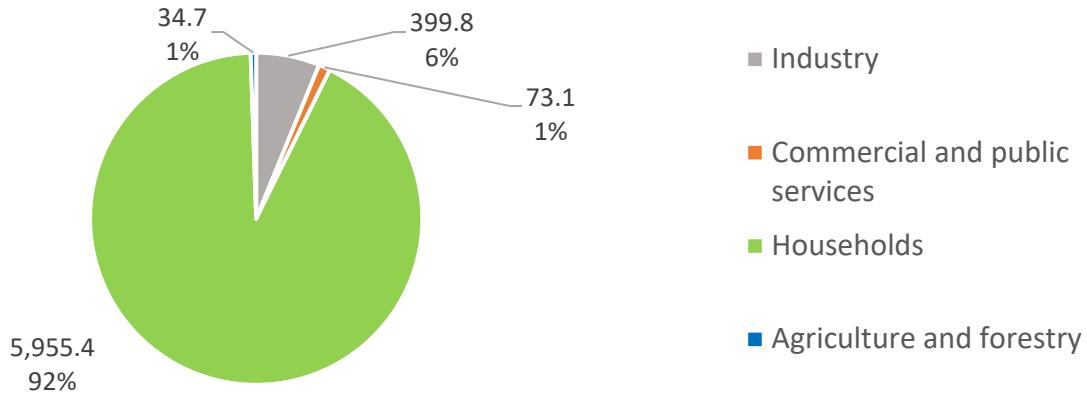

Figure 31 Breakdown of the final energy consumption of primary solid biofuel per end-use sector in Italy in 2020. Source: Eurostat

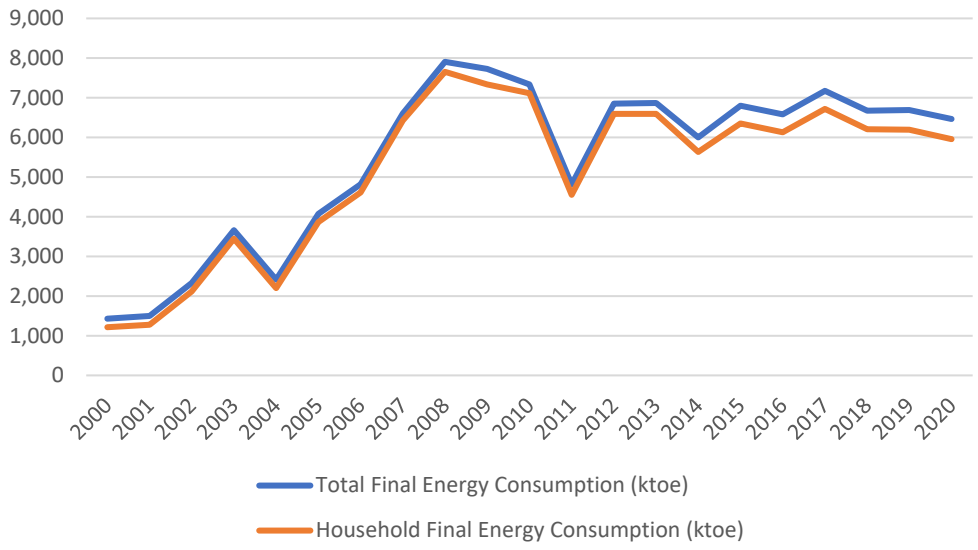

Figure 32 Evolution of the total Final Energy Consumption of solid biomass and Household Final Energy Consumption of solid biomass in Italy in ktoe. Source: Eurostat

When looking at Figure 33 and Figure 34, we can see that over the last 20 years, the quantity of biomass consumed by households represents almost the entirety of the solid biomass consumed by the country, which illustrates the capital importance of this resource in order to ensure the needs of certain inhabitants.

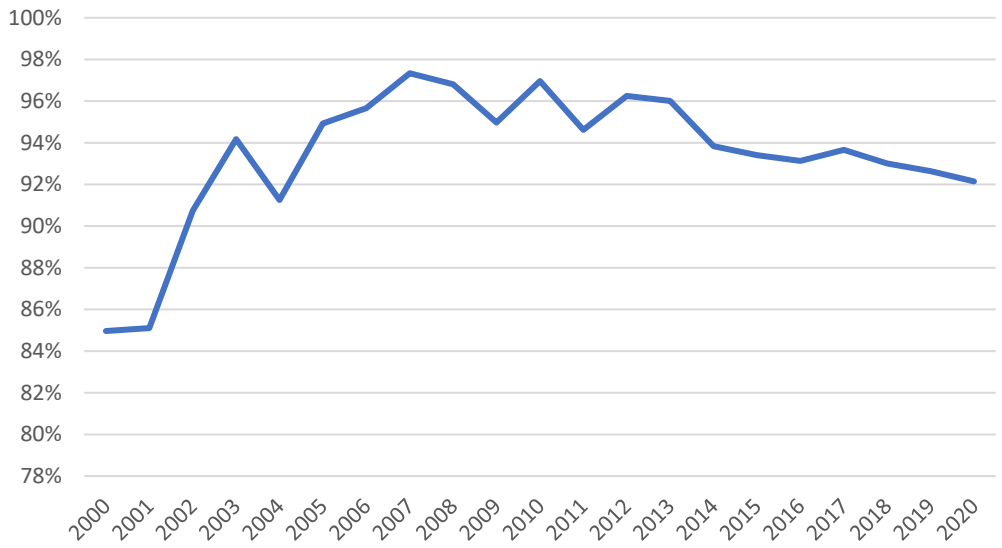

Figure 33 Evolution of the share of the Final Energy Consumption of solid biomass consumed in households out of the total solid biomass consumption for energy in Italy. Source: Eurostat

Agrobiomass state of play in the country

in the EU27, Italy ranks sixth in terms of the area dedicated to crops, with a total value of 9,329,070 ha. However, it is worth noting that the difference between Italy in sixth place and Hungary in seventh place is almost 5.000.000 ha, which underlines the importance of Italy in European agriculture, even though it ranks only in sixth place. In terms of proportion, the country ranks eleventh, with 32% of its land area dedicated to crops. This value may again seem low, but the average value of agricultural proportion in the EU27 is 27%. An important point regarding agriculture in Italy is the proportion of croplands placed under permanent crops. In fact, this proportion amounts to 26% in Italy, which ranks fourth in Europe in this field, ahead of other Mediterranean countries such as Portugal, Greece, and Spain (at 46%, 34% and 30% respectively).

In Table 9, it is possible to see an estimate of the agrobiomass potential for energy in 2030 according to a study carried out in 2021 (Panoutsou & Maniatis, 2021) for different types of agricultural feedstocks.

Table 9 2030 Bioenergy potential per type of agricultural feedstock in Mtoe in Italy. Source: (Panoutsou & Maniatis, 2021)

Type of Agrobiomass	2030 Bioenergy Potential (Mtoe)
Cereal straw	1,50
Maize stover	1,13
Oil crop field residues	0,13
Agricultural pruning	0,20
Manure	2,92
Secondary Agricultural residues	1,04
Lignocellulosic crops	0,25
Total	**7,17**

It is clear that the potential for agrobiomass in Italy is relatively large. However, we also see that the category representing the greatest potential is "manure", which is not exactly a feedstock that can be used as such in agricultural biomass heating systems.

If we want to put this potential in perspective with a current known data, the Final Energy Consumption in households in 2020 was 30.656 Mtoe for all types of energy, and this agrobiomass potential could therefore theoretically cover almost a quarter of the energy consumption of households. A more detailed analysis of the current distribution of the different fuels used for residential heating in Italy (Figure 35) shows that solid biomass represents a quarter of the domestic energy mix. It can also be noted that Italian households are extremely dependent on gas imports, as the latter represents 2/3 of the mix in 2020. With the current geopolitical crisis, leading to a decrease in natural gas supply and a significant price increase, it is possible that more residential users will turn to biomass for their needs and that the share of biomass will increase by 2021/2022.

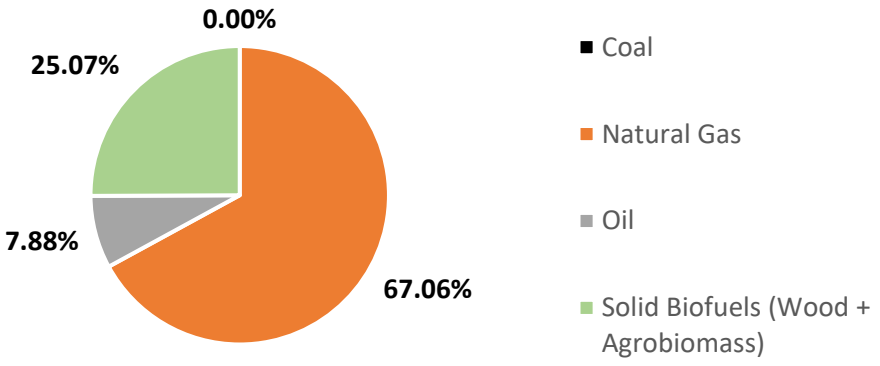

Figure 34 Fuel consumption for residential heat in 2020 in Italy. Source: Eurostat

When we now look at the commercial and public services sector on Figure 36, it is clear that biomass plays only a minor role in this market. In fact, this sector is largely dominated by natural gas installations, which account for nearly 92% of the sector's energy consumption for heating. Given the current distribution, a greater development of biomass installations in the commercial sector does not seem to be a certainty, but this could potentially change depending on the support policies that will be implemented in Italy.

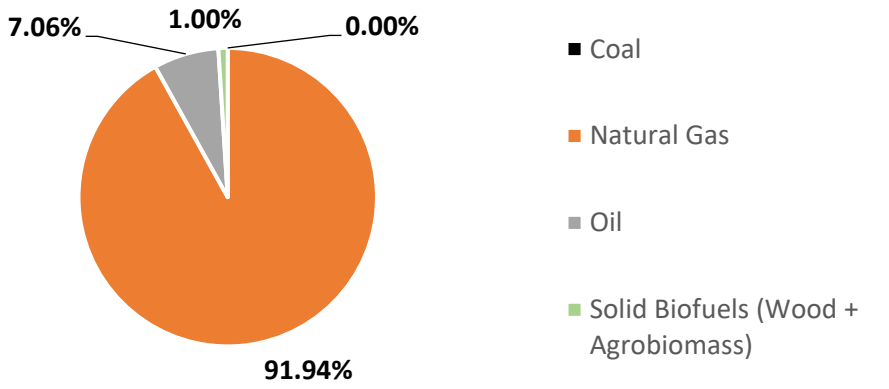

Figure 35 Fuel consumption for commercial/public services sector in Italy in 2020. Source: Eurostat

Finally, a last sector of potential interest when talking about Agrobiomass is everything related to decentralised heating. Figure 37 shows the current distribution of the different fuels used in this sector. Thus, we can see that as it is in the residential sector, natural gas represents 2/3 of the sector's energy consumption. Solid biomass accounts for about 10% of the mix, and this percentage rises to about 18% when other forms of biomass are also included. Thus, it would seem that biomass can play an important role in district heating systems, especially in the more rural areas.

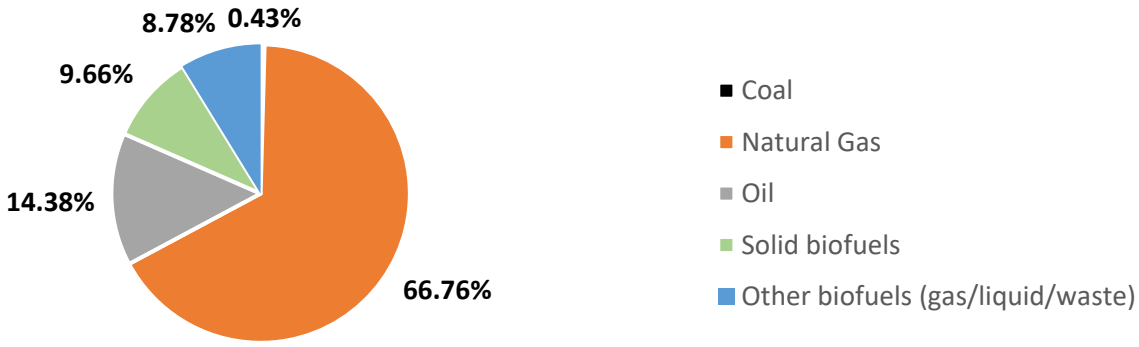

Figure 36 Fuel consumption for derived heat in Italy in 2020. Source: Eurostat

Annex VIII – EU Green Week 2021 and 2022 event

Bioenergy Europe, in collaboration with AgroBioHeat consortium partners, organised a webinar in the context of the 2021 EU Green Week to show that, despite little awareness, several studies and practical examples demonstrate clear benefits of the use of locally available biomass from agriculture. During the webinar, experts shared their views on the potential and challenges related to the use of agricultural residues for energy production, focusing on the environmental and socio-economic benefits of this sector.

Figure 37 EU Green Week Promotional banner

Focusing on the environmental and socio-economic benefits of agrobiomass, the event assessed the way forward to capitalise on the untapped potential for rural communities and Europe as a whole. In particular raising awareness on agricultural practices, benefits of agrobiomass valorisation, increased cooperation among farmers and most importantly, access to funding.

The project coordinator, **Manolis Karampinis** (Centre for Research and Technology Hellas, CERTH) opened the event giving an overview on the current state of the agrobiomass sector. In his keynote speech, Ola**f Nährig, f**rom Amandus Kahl, highlighted that agrobiomass adds value in rural areas by increasing income for farmers and boosting the efficiency of the local infrastructure. He also pointed out that readily available advanced technologies play an important role in reducing emissions when utilising agricultural residues.

Kicking off the panel discussion on the obstacles in the optimal use of agricultural residues, **Jérôme Maillet**, COMPTE.R, stated that when producing the equipment, a standardization of material is needed to assure homogenous quality. Another challenge is that every type of residue is different and specific needs (e.g. gross and net value, physical shape, chemical composition…) must be considered. As a

producer of briquettes from straw, Bar**bara Pokrzywa (**Asket) highlighted current misconceptions on straw efficiency, open field burning practices and financial burdens for famers when adopting biomass technologies. Agrobiomass can become a driver for rural socio-economic development, contributing to energy safety and independence, and fighting energy poverty being aligned with the EU Green Deal's objectives.

Michael Wolf, DG AGRI (European Commission), confirmed that there are untapped biomass sources available from abandoned or not fit for food production land. Therefore, it is paramount to develop value-chains in which primary producers are fully and effectively integrated. **Tajana Radić**, Croatian Chamber of Agriculture reiterated the need to raise awareness on agrobiomass potential and couple it with investments aimed at promoting the valorisation and mobilisation of agricultural residues. Despite successful agrobiomass business models, financial and organisational support schemes to implement these models are still needed. Cooperatives and producer associations are a viable solution to help farmers re-organise themselves. **Daniel Garcia** (Spanish Biomass Association - AVEBIOM), stressed that agrobiomass is more complex than woody-based one and consequently the price of handling mobilisation can be higher and represents an obstacle. In addition, unused biomass sources need to be supported by policies and incentives to facilitate the possibility to mobilise them and to increase the demand. There is a limited understanding that bioenergy is totally compatible with carbon capture and sustainable soil management. A public debate is needed so that policy makers can make informed decisions that are most beneficial for society and the ecosystem. In order to foster the development of the agrobiomass heating sector, what needs to be done includes:

- **New / dedicated policies and support**; an opportunity that should not be missed in the new CAP framework and the possibilities provided by the Eco-schemes.
- **Suitable business models**; the fundamentals are well familiar to the agricultural sector (e.g. cooperative schemes), but there are also "modern" variations (e.g. energy communities), which are well suited for agrobiomass mobilisation.
- **Awareness raising actions**; primarily targeting farmers, policy makers and regional developers.

The benefits of agrobiomass mobilisation are quite clear: low-cost rural decarbonisation, rural development opportunities, contribution to the bioeconomy and circular economy, and the use of European resources and technological solutions for European needs. A full recording of the event is available in the AgroBioHeat project website.

2022 Final AgroBioHeat Event – Agrobiomass: A Rural Solution in the Green Transformation

The final event of the AgroBioHeat EU-funded project took place on June 2, both at the Scotland House (Brussels) and online. The hybrid event was a great success, with more than 70 participants joining the debate and **discussing challenges and opportunities for agrobiomass applications**.

The session was opened by **Elsi Katainen**, Member of the European Parliament and Vice-chair of the Agriculture and Rural Development (AGRI) committee. She touched upon the **different aspects of the agricultural sector and stressed how we will need renewable solutions like biomass from the agricultural sector** to be part of the EU future energy mix.

Given that AgroBioHeat is coming to an end, it was timely to look more specifically at the achievements of the project. **Manolis Karampinis,** the project coordinator from CERTH – Centre for Research and Technology Hellas – explained the overall approach and activities. He went into detail on several emerging agrobiomass initiatives that were supported by the project in Croatia, France, Greece, Romania, and Spain, and the general prospects for the development of agrobiomass.

Georgiy Geletukha, Head of the Board of UABIO, the Ukrainian Bioenergy Association, joined the conference remotely to give a presentation on the Ukrainian context. He showed results from the project from a national perspective, stressing how agrobiomass has the capacity to substitute vast amounts of fossil fuels in the future efforts for restructuring the Ukrainian economy.

The event then moved on to a broader dimension with the panel discussion, featuring experts from different EU regions and active in several sectors: **Barbara Pokrzywa**, Sales Director, ASKET – a family owned company from Poland offering mobile solutions for straw briquetting; **Tajana Radic**, Head of Division at EIP-AGRI – a network that aims to facilitate knowledge transfer and promotion of best examples in the EU agricultural sector; **Tihamér-Tibor Sebestyén**, from Green Energy Innovative Biomass Cluster – a Romanian organization supporting the development of solid biomass heating and partner of AgroBioHeat; **Eric Nederhand**, Director for EU Government Relations at Olam Food Ingredients (Ofi) – a global leader in the agro-food sector with several biomass installations that use food residues to cover process energy demands on-site.

The conversation touched upon **examples from industry, barriers to residential applications, as well as solutions and best practices** from research. The potential of agrobiomass was thoroughly debated and speakers presented several solutions to overcome possible challenges and barriers. Some of the key phrases included words like **“raising awareness” and “knowledge sharing”, highlighting that there are many feasible options to use residues that are already available** (like straw, agricultural prunings, agro-industrial residues or other fractions) to produce clean energy and diversify farmers’ income.

Another crucial aspect is the local dimension. These projects showed the synergies that exist when local actors are able to tap into their own local resources. In order to fully benefit from these success cases, they need to be widely promoted and further replicated. In this context, **a stable and predictable policy framework recognizing the potential of agrobiomass, and the right financial incentives are still needed.**